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FISH FARMING METHODS IN THE PHILIPPINES INDONESIA AND HONG KONG

by

T. Gottfried Pillai
(Fisheries Research Station, Colombo, Ceylon)

FISHERIES DIVISION, BIOLOGY BRANCH
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, March 1962

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PURPOSE OF THIS SERIES

This is one of a series of Technical Papers (see inside front cover) dealing with various aspects of the work of FAO Fisheries Division, Biology Branch, including the review of pertinent information on particular topics, to meet requests for assistance, for presentation to technical and scientific meetings, etc. Extra copies can be obtained by application to:

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PREPARATION OF THIS DOCUMENT

Account based on reports submitted during a fellowship awarded by FAO under EPTA, from April to October, 1960, of which five months were spent in the Philippines, one month in Indonesia and a week in Hong Kong. For submission to the governments in the countries visited for the information of fish culturists in these and other IPFC member countries. Drafted by T.G. Pillai, edited in Inland Resources Section, FAO Fisheries Biology Branch.

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Fish farming methods in the Philippines, Indonesia and Hong Kong

Report on information gathered during a fellowship granted by FAO under the Expanded Program of Technical Assistance, on methods of brackish and freshwater fish farming, especially the former. Refers to Chanos, shrimps, siganids, Ostrea, Mytilus, Mugil cephalus, Puntius javanicus and Cyprinus carpio.

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FISH FARMING METHODS IN THE PHILIPPINES, INDONESIA AND HONG KONG

by

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This is a brief report on the methods of brackish- and freshwater fish farming, as practised in the Philippines, Indonesia and Hong Kong. The information in this report was gathered during a twenty-five week study tour of these countries, on a Fellowship granted by the Food and Agriculture Organization of the United Nations. More importance was assigned to brackishwater fish farming methods during these studies. The material has been arranged and presented as a guide. It may also serve as a basis for the classification and accumulation of data on fish farming methods.

1. MILKFISH FARMING

1.1. Conditions necessary for farming milkfish successfully.

The following factors will have to be taken into consideration when intending to farm milkfish (Chanos chanos Forskal).

1.1.1. Availability of milkfish fry. Milkfish fry should be regularly available, in quantities sufficient to stock the intended area of fish ponds.

1.1.2. Suitable range of tidal movement. There should be a suitable range of tidal movement in the area intended to be converted into fish ponds. It should be possible to retain a least one to two feet of water in the ponds during low tide or drain the ponds completely at low tide. Draining and drying of the pond bottom helps to eradicate unwanted fish and pests. It also promotes the growth of blue-green algae and green algae which constitute the chief food of milkfish, under cultivation.

1.1.3. Clean water supply. The tidal streams and rivers that supply the intended pond area with water should not be subject to contamination especially by discharges of oily or poisonous chemical wastes from industrial plants.

1.1.4. Nature of the land. It is cheaper to build on level tidal flats (Fig. 1 and 2) and on swamps and marshes without thick vegetation (Fig. 3). Uneven land or dense mangrove forests will push construction costs higher, but even these sites can be used profitably. Areas subject to floods should be avoided, especially where flooding is frequent.

1.1.5. Soil consistency. Fish ponds should be built in soils which hold water and are suitable for good algal growth. Sand, rock, stone and shell bottoms are unsuitable. The best soils are those composed of mud and clay or loam and clay. Sandy mud may be good if there is more mud than sand.

1.1.6. Soil pH. The pH of the soil plays an important role in determining algal growth. A pH of 6.5 to 7.5 favors rapid algal growth. Hence soils within the optimum pH range are preferable. Those with pH values less than 6.5 will have to be improved by the regular addition of suitable quantities of agricultural lime or quicklime and this will involve recurrent expenditure for highly acid soils.

Fig. 1. A view of the Pacific Fish Farm at Tambak (Zaragoza, Alaminos, Luzon). About 600 hectares of tidal flats have been reclaimed from the Lingayen Gulf for milkfish farming and solar salt production.

Fig. 2. Ponds constructed by reclaiming tidal flat in Lucop (Alaminos, Luzon). Blocks of coral are used for forming the dykes. As water cannot be retained during low tide by the coral dykes the ponds are used chiefly for oyster culture. The Pangasinan School of Fisheries is in the left background.

Fig. 3. Picture showing the nature of the land that is generally converted into milkfish ponds. The foreground shows scanty vegetation and the background shows a mangrove forest.

1.1.7. Market for farmed fish. Unless there is a market for farmed fish, or a potential market, the venture will fail financially. It is most important to determine the demand for farmed fish before investing time and money in the project.

1.2. Layout and construction of milkfish ponds.

The area to be converted into fish ponds is first surveyed and a plan is drawn of the layout of the dykes and the positions of the sluice gates in relation to the water supply.

1.2.1. General layout of ponds. Each pond system generally consists of 1) nursery ponds, 2) "transition ponds" or intermediate ponds and 3) final ponds or harvesting ponds.

The nurseries are a series of small, shallow ponds near the water supply channel, constituting approximately one percent of the total pond project. The small and delicate fry are are reared in them till they grow to fingerlings, up to about 2 inches in length. Most nurseries have a smaller pond within them in which the delicate fry are allowed to grow for a few weeks before being released into the rest of the nursery.

The area of each intermediate pond is about one-half to one hectare. The total area of these ponds is usually about eight to nine percent of the total pond area of the project. In these ponds, fingerlings are reared until they are three to five inches long.

Final ponds, or "harvesting" ponds, may be from one to 15 hectares in size and take up the remaining 90 percent of the total pond area. The fish are grown in the final ponds to market size.

1.2.2. Easy and economical to operate layout of ponds. The ponds are best layed out in such a manner that they are along one or two sides of (Fig. 4) or surrounding (Fig. 5) a common, water-supply and harvesting pond. Often this common pond is also called the catching pond. Pond systems layed out in this manner are easy and economical to operate. In Dumangas (Iloilo, Philippines), a 55-hectare pond system constructed on these lines is operated by one caretaker.

1.2.3. Implements used for excavation work. The implements used for pond excavation work are similar in the Philippines and Indonesia. The implement most commonly used in the Philippines is a flat, steel blade, about 60 cm long, 10 to 15 cm wide at the tip and narrowing to about 5 cm towards the somewhat dumb-bell-shaped wooden handle which is fixed in line with the blade. In the Malabon Region of the Philippines, however, a T-shaped tool, which is fundamentally similar but with a transverse wooden handle is also used. In the Philippines, the blades of the digging tools are often made out of the discarded leaf springs of heavy motor vehicles as they are very durable and strong enough to be used for hacking through mangrove roots without being dented. In East Java, the digging implement may be wholly of steel (Fig. 6) or with the handle and most of the blade of wood and the tip of the blade of steel (Fig. 7).

In the course of excavation, the blade is driven vertically along the sides of the block of earth to be removed. The required pressure is applied vertically and the blade rocked backwards and forwards along each side of the block, and the whole block removed. As far as possible, the earth is removed in rectangular blocks, each block being approximately 50 cm x 20 cm x 20 cm, and they are neatly arranged to form the dykes (Fig. 8). If roots are encountered, the blade is used to hack through them.

In the Philippines, mechanical earth grabbers fitted to cranes on floating devices are sometimes used in the construction of very large pond projects. These can be successfully operated during high tide, in places where there is a high range of tidal movement.

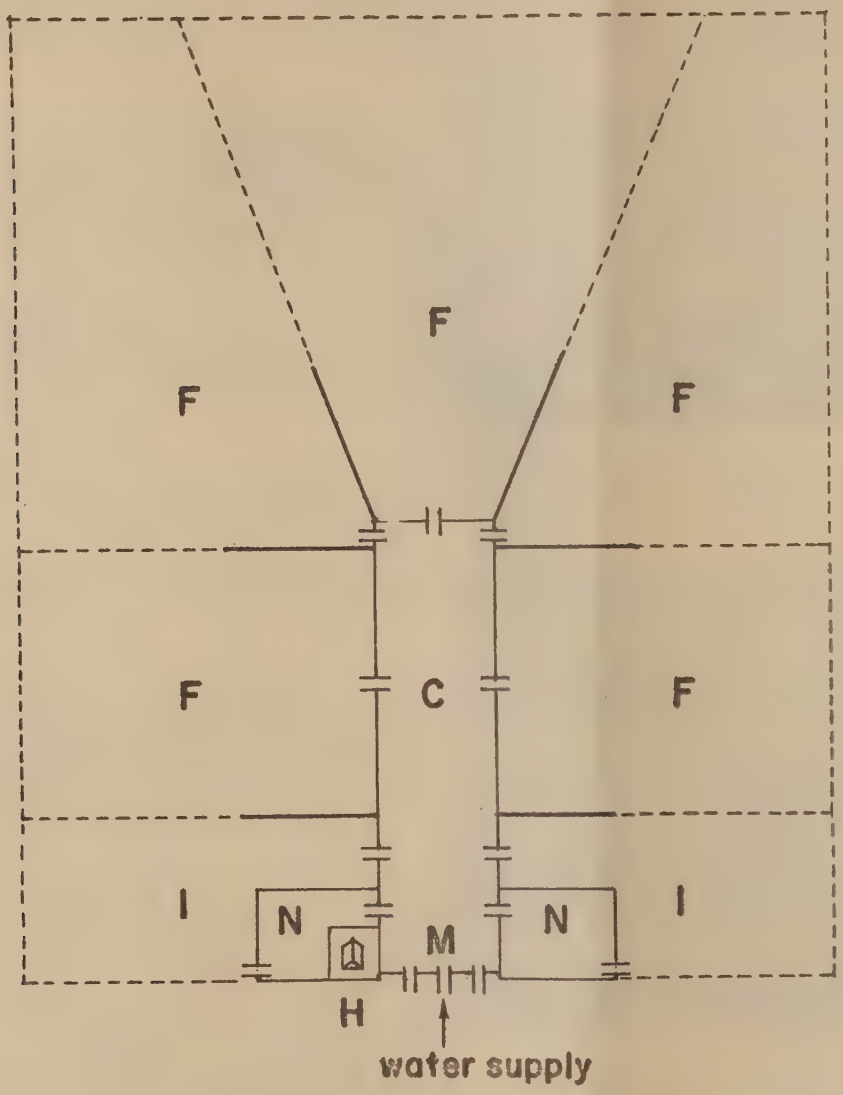

Fig. 4. Diagram showing an easy and economical way to operate layout of milkfish ponds, with the various ponds situated on two sides of a common ponds. C - common water supply cum catching pond; M - multiple sluice gate to the common ponds. It can be a single sluice gate if the pond area is small. H - caretaker's hut. N - nursery pond. I - intermediate pond. F - final or harvesting pond.

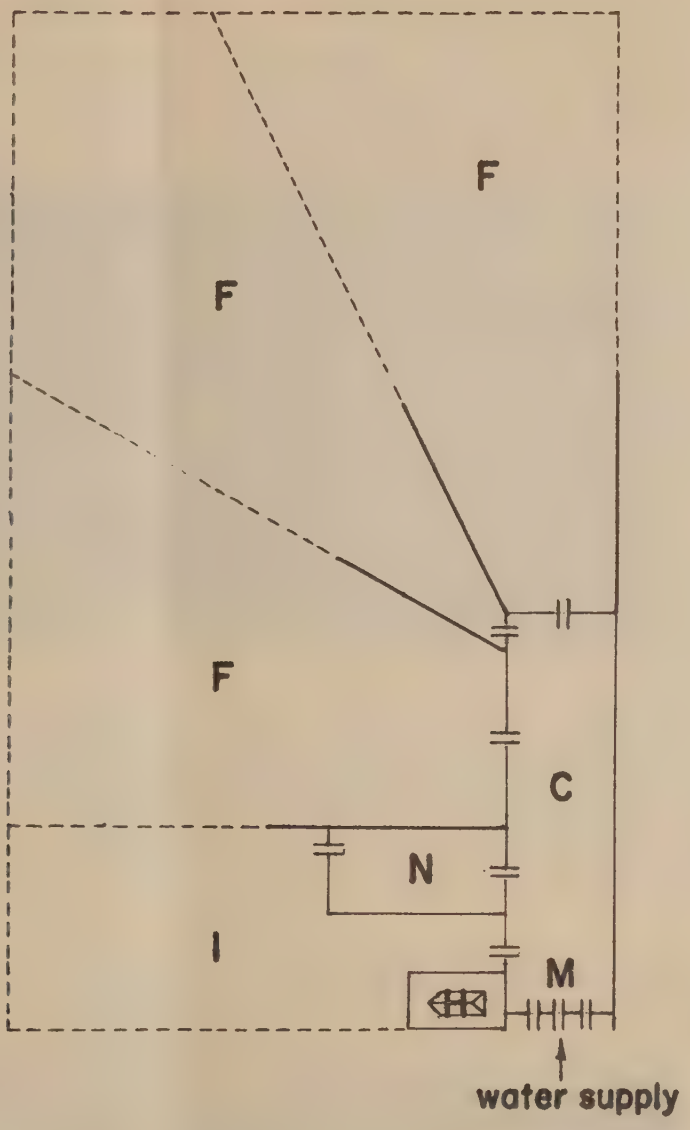

Fig. 5. Diagram showing an easy and economical way to operate milkfish ponds, with the various ponds situated along three sides of a common pond. C - common water supply cum catching pond. M - multiple sluice gate to the common pond. H - the caretaker's hut. N - nursery pond. I - intermediate pond. F - final or harvesting pond.

Fig. 6. An all steel digging implement used for pond excavation work in East Java. A type of boat used for transporting excavated earth is shown in the left background.

Fig. 7. A steel-tipped wooden blade used for pond excavation work in East Java.

1.3. Dykes and their construction.

1.3.1. Kinds of dykes and principles of construction. There are main or primary, secondary and tertiary dykes in a pond system. The main dykes are those that run along the outline of the pond system. These are generally subject to the rigors of tidal action, wave-action (especially during the passage of boats along tidal streams), flooding of the tidal rivers during rains, and the pressure of the water retained within the pond system, which is most significant at low tide. Hence the main dykes have to be very strongly constructed. The top of the main dyke should be at least 50 cm higher than the highest tide during the year and there should be at least 1.25 to 1.75 meter horizontal measurement at the base for every meter rise of the dyke. Usually, the main dykes in the Philippines and Indonesia are about 1.5 to 2.0 meters high. The secondary dykes are those that divide the pond system into major or final ponds. The tertiary dykes partition the smaller intermediate and nursery ponds and they are smaller than the primary and secondary dykes.

1.3.2. Dyke construction. Dyke construction commences by getting rid of plants and other material along the path of the main dykes and, subsequently, the other dykes. Next, the limits of the dykes, including the height, width and slope are marked with stakes or pegs and strings (Fig. 8 and 9). The blocks of excavated earth are transferred from the place of excavation and neatly arranged to form the dykes.

1.3.2.1. Transfer of excavated earth. During the initial stages of dyke formation the earth will have to be carried only short distances and this is usually done manually (Fig. 8). Walking on planks which are rested on unexcavated blocks (Fig. 10), facilitates the manual transfer of earth and also cuts down much time otherwise spent in walking through mud. Certain floating devices are used to save labor and time on longer distances. Generally, in the Philippines and Indonesia, bamboo rafts or small boats (Fig. 11) are used. In recent times, a floating device with a flat top and bottom has been developed in the Philippines. It was first designed by Messrs. Leonardo and Conrado Denila of Iloilo City. Its external dimensions are 14 feet x 5 feet x 1 foot. Its sides are sealed except for a small square opening at the top, and it can transport a load of about a cubic meter of earth. This device (Fig. 8) can be used in water as shallow as about one foot. Any water that may leak into this float can be let out through the hole at the top, tilting the float. Several variations of this basic design are used in the Visayan Region of the Philippines.

1.3.2.2. Arrangement of earth blocks to form dykes. The arrangement depends on the nature of the soil. If the blocks have no roots or are composed of loose soil, there is no particular direction in which they are arranged. If they have roots, they are arranged so that the blocks in the dyke centre have the roots within them lying parallel to the dyke and the blocks outside them have their roots perpendicular to the length of the dyke (Fig. 8). This method has been found to minimize dyke erosion and water seepage.

1.3.2.3. Tightening of soil and shaping of dykes. Dykes are not generally built to their intended height at once. Instead the earth is arranged in layers, rammed and allowed to harden before other layers are added. Various implements, fundamentally similar, are used for tightening dyke soil. One such simple device, used in the Philippines, is a heavy, rectangular block of wood fitted with two handles (Fig. 12).

1.4. Levelling the pond bottom.

With excavation and dyke construction there should also be levelling of the pond bottom with a gradual slope towards the positions of the sluice gates. This facilitates pond draining. After the initial rough levelling, which involves the removal of tree stumps and mounds and filling up pits, the fine levelling is done with a hoe (Fig. 13).

Fig. 8. Excavated blocks of earth being neatly arranged to form the dykes. The blocks on the outside are arranged so the roots within them are at right angles to the length of the dyke while those in the center are arranged with their roots parallel to the length of the dyke. The flat-bottomed floating devices for transporting the earth are shown on the left. The method of marking the dimensions of the dyke is shown in the right foreground.

Fig. 9. Another view of the dyke shown in Fig. 8. The right foreground shows a part of the dyke that has been constructed earlier and allowed to settle before increasing its height.

Fig. 10. Facilitation of the manual transfer of earth by walking on planks.

Fig. 11. A boat used for transporting excavated earth in Indonesia.

Fig. 12. A simple device used for tightening dyke soil in the Philippines.

Fig. 13. A simple device used for the final stage of levelling the pond bottom in the Philippines.

1.5. Partial construction of ponds.

Often fish pond owners do not construct ponds completely. They construct as much as their finances will permit, stock the partially-constructed ponds with fish and make use of the profits from the harvests for the further development of the ponds (Fig. 14).

1.6. Sluice gates.

Sluice gates are of different sizes and may be single or multiple, depending on the needs of the various ponds. Usually there are primary, secondary and tertiary sluice gates. The primary, or main gates, control the supply of water into the whole pond system from its source. They may be single or multiple, depending on the area dependent on them, the width of the main water supply channel and the range of tidal movement in the area. The secondary sluice gates control the supply of water to the final or harvesting ponds. The tertiaries are at the entrances to the intermediate and nursery ponds. The secondaries are smaller than the primaries and larger than the tertiaries.

Generally, sluices do not exceed 100 to 125 cm in width. Wider ones would be too cumbersome to operate. The need for wider sluices is met by installing two or more smaller sluices side by side to form a compound sluice gate.

Sluice gates are either open type or culvert type. The open types are similar to those generally used for agricultural irrigation systems. They consist of a bottom and two sides. The sides have provision for sliding wooden slabs or screens (Fig. 15). The two side-walls of the sluice may be extended at either end, at an angle, to flank the dyke.

The culvert types are either circular or rectangular in cross-section and pass through the bottom of the dyke from the water supply channel to the pond. The earth is heaped over them to form an uninterrupted continuation of the dyke. The ends of the culvert type of sluices have grooves for sliding either wooden slabs or screens.

Either the open type or the culvert type of sluice gate can be used at the entrances of any of the ponds, although the open type of sluices are more commonly used.

The main body of the sluice gates can be either concrete or wood. For primary sluice gates they are generally concrete (Fig. 16), with a strong bottom foundation. The secondary and tertiary sluices are wood (Fig. 15) or bamboo (Fig. 17). If wood, the wood must be resistant to wood-borers and decay in water. Alternatively, the wood has to be impregnated with anti-wood-borer chemicals. In the bamboo sluices, the bottom is wood and the sides are of longitudinally split bamboo. In several parts of the Philippines the bamboo is slit longitudinally in several places into about one-inch strips, without separating the strips. A subsequent longitudinal split from one end of the bamboo to the other enables the bamboo to be spread out into a narrow sheet as wide as the circumference of the bamboo. This is then cut into sections as long as the intended sluice, placed one above the other and supported on bamboo struts to form the side walls of the sluice. In Indonesia (East Java) the side walls of the bamboo sluices are made of woven bamboo strips (Fig. 17). There are wooden slots, in these bamboo sluices, for sliding wooden slabs or screens.

The height of the water in the ponds and the inflow or outflow of the water is regulated by means of wooden slabs which can be slid into the slots of the sluice mechanism to the required height. Water leaks caused by imperfect fitting of the slabs in the slots can be stopped by piling mud against the slabs to the required height.

Fig. 14. A partially constructed milkfish pond in the Philippines. Such ponds are stocked with milkfish and the profits from the harvests are used for the further development of the ponds.

Fig. 15. A wooden nursery sluice gate in a Philippine fish pond.

Fig. 16. The concrete main gate of the Government Demonstration Fish Farm at Molo, Iloilo City, Philippines. The tidal river that supplies the pond system with water is in the background.

Fig. 17. A bamboo sluice gate used in East Java.

Fig. 18. Cone-shaped bamboo frames which are covered with pineapple fiber cloth and used at the entrances to nursery ponds in the Philippines.

Screens are used at the sluice gates to keep unwanted aquatic animals from the ponds and to prevent fish escaping as water pours through the sluices. The screens are of various mesh sizes and of various materials. The finest screens are used at the entrances to the nursery ponds. They are made of strong and durable fine-meshed cloth (pineapple fiber cloth in the Philippines), fixed to wooden frames that can be slid into the slots of the sluices. In the Philippines, a cone-shaped bamboo frame (Fig. 18) covered with a pineapple fiber cloth is used as a screen for nursery ponds. The opening of the cone, situated at its base, is fitted against the opening of the culvert type of sluice which is usually fashioned from the the hollow trunk of certain palms. The other end of the cone is firmly staked to the ground, within the pond, through a hole meant for this.

The screens used for the final ponds and intermediate ponds are usually made out of bamboo strips. Bamboo strips with a uniform diameter of 0.50 to 1.0 cm are either fitted into wooden frames that can be slid into the slots of the sluices, or woven with strings to form long screens (Fig. 19). The spaces between the bamboo strips of the screen are about three to five mm. These screens are fixed in the form of a V, by means of stakes, within the pond (Figs. 19 and 20). The bottom of the two screens that compose the wings of the V are driven a few centimeters into the mud.

1.7. Milkfish fry, their capture, handling, transportation, etc.

1.7.1. In the Philippines. The chief milkfish fry grounds of the Philippines are along the north-western coast of Luzon (Pangasinan, La Union and Ilocos Sur). Milkfish fry are also collected from several other parts, including Davao and Zamboanga in Mindanao. Fry capture is such a well-established and vital industry by itself that certain stretches of fry grounds are leased annually to the highest bidder by the local administration.

1.7.1.1. Methods of fry capture. Two methods are used at the mouth of the Calmay River in Pangasinan. In one, a fine meshed net supported on a crossed bamboo frame (Fig. 21) is towed by two persons (Fig. 22) along the shallow parts of the sea and estuaries. After towing for a while, the device is lifted in such a way that the fry gather in an immersed corner of the net. Water is splashed onto the sides of the net if necessary (Fig. 23), and a white basin or bucket is introduced into this corner and the fry removed with some water. The fry are then sorted with a white cup or shell.

In the second method at the mouth of the Calmay River, wooden planks or bamboos are staked to the ground in shallow water, in the form of a V. At the angle of the V is fixed the same device that is used in the first method (Fig. 24). The fry that swim down the wings of the V collect in it and are periodically collected as in the first method.

A slight variation of the second method is used at Pogoro Island, in the vicinity of Dagupan City. Here the wings of the V are of bamboo, but the fry collector at the angle of the V is a fine-meshed gutter-shaped device suspended from a pair of parallel, floating bamboos (Fig. 25). The first method is also used in Pogoro Island.

Two other methods are used at Carlattan (San Fernando, La Union). In one, a fine-meshed rectangular net fixed to bamboos (Fig. 26) is dragged along the shallower parts of the sea by two men. The bamboos are held vertically while the net is operated. Periodically the net is lifted in such a way that its middle, with the fry, remains under water. The fry are collected in a basin or bucket and sorted in the usual manner.

In the second method at Carlattan, a series of wooden V-shaped devices are arranged side by side across an estuary (Fig. 27). At the angle of each V-shaped unit there is a fine-

Fig. 19. Side view of the arrangement of bamboo screens at the entrance to a Philippine milkfish pond. The pond is on the left and the supply channel on the right (not shown).

Fig. 20. Another view of the bamboo screen arrangement shown in Fig. 18. The water supply channel to the pond is in the foreground.

Fig. 21. A fine-meshed milkfish fry capturing device used at the mouth of the Calmay River in Pangasinan, Philippines.

Fig. 22. The operation of the device shown in Fig. 21. The fry bucket and the sorting basin are in the hands of the fry gatherers.

Fig. 23. Splashing of water on the outside of the fry collecting device to concentrate the fry in the submerged corner of the net. The basin is introduced into this corner and the fry removed into it with some water.

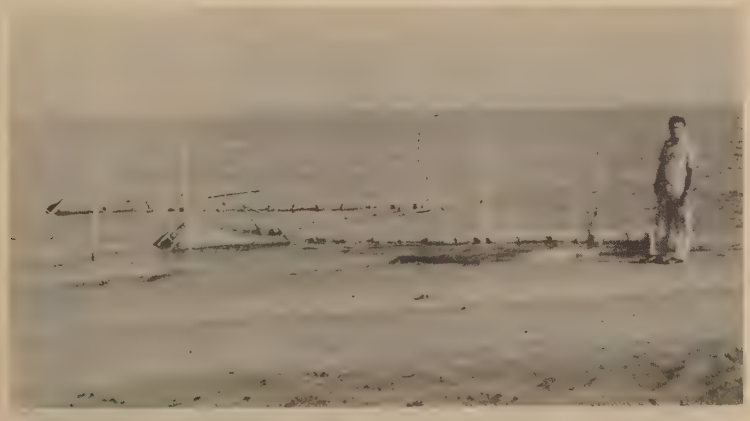

Fig. 24. Another method of using the device shown in Figs. 21-23, at the mouth of the Calmay River, Pangasinan, Philippines. The fry that come along the wings of the V-shaped wooden arrangement concentrate in it and are periodically collected in the usual way.

Fig. 25. A slight variation of the method shown in Fig. 24. It is used around Pogoro Island, Pangasinan, Philippines. The V-shaped arrangement is out of bamboo. The fry concentrate in a gutter-shaped, fine-meshed net suspended between two floating bamboos. The foreground shows a fry gatherer who uses the method shown in Figs. 21-23 sorting his fry.

Fig. 26. A simple, rectangular, fine-meshed device for the capture of milkfish fry in San Fernando, La Union, Luzon, Philippines. It is operated by two men who drag it vertically in the water.

Fig. 27. The method employing a series of V-shaped, wooden devices arranged side by side across an estuary in Carlattan, San Fernando, Luzon, Philippines. The fry collect in the fine-meshed, gutter-shaped nets found at the junctions of the V-shaped devices.

meshed gutter-shaped net, suspended from two parallel bamboos (Fig. 28). The device is operated at high tide. Hence the gutter-shaped fry collector is situated away from the mouth of the river. The fry that collect in it are periodically collected and sorted in the usual manner.

1.7.2. In Indonesia. Although milkfish fry are available in several parts of Indonesia, the chief fry grounds are in East Java and Madura. In East Java, the fry grounds extend from Toeban to Muntjar. The fry are also abundantly available around the islands of Madura, Gilrado, Giligentino and P. Sapudi.

A long rope, with palm leaves closely strung on it, is used in one of two ways to capture the fry.

1.7.2.1. The straight rope method. The fry collectors' gear (Fig. 29) consists of the grass rope, bamboo stakes, a fry pot, a shell for sorting fry, and a fine-meshed net fixed to a triangular frame.

In the straight rope method, the palm leaf rope is tethered to a row of bamboo stakes at right angles to the shore line (Fig. 30). The height of the palm leaf rope can be adjusted according to the tides. The floating rope serves as a shelter, perhaps as a barrier, for the milkfish fry that are wafted about by the waves. They are collected with the fine-meshed net which is taken back and forth along and under the palm leaf rope. The shell is used to transfer the fry from the net to the pot. The straight rope method can be operated in depths that would permit a man to wade, even chest deep, from one end of the rope to the other.

1.7.2.2. The looping rope method. This method is used in very shallow water that will permit a part of the palm leaf rope to be above the surface of the water, while resting on the bottom of the sea. A bamboo stake is first planted at the water line on the shore. One end of the rope is tied to it and the other taken out into the water in the form of a wide arc and finally a circle. The free end is next crossed over the fixed end (Fig. 31) and pulled over it in short lengths in order to decrease the area within the circle (Fig. 32). The fry that have been concentrated together by the decreasing circle are then collected with a fine-meshed net and transferred into the fry pot with a shell, as in the straight rope.

1.7.3. Handling of fry. Owing to their delicate nature, milkfish fry are always transferred, either from the capturing device to the sorting vessel or from one vessel to another, in water. In the Philippines, since large devices are used for the capture of milkfish fry, the fry are removed from the fine-meshed capturing net with a white basin or bucket (Fig. 22). From this they are sorted into the fry containers with a use of a white cup or bivalve molluscan shell. In Indonesia, since the fine-meshed device is small, the fry are removed from it with the use of a small shell (Fig. 30).

1.7.4. Sorting of fry. The fry of certain other species of fishes and of certain crustaceans are generally captured with milkfish fry. Great care is taken to discard the fry of predaceous fishes as these, when stocked in ponds with milkfish fry, are responsible for considerable milkfish losses. The sorting is done by means of a white cup or shell (Fig. 33), the unwanted species being discarded in the process of transferring the milkfish fry, a few at a time, from the sorting vessel to the fry container. The sorting vessel is usually a white basin.

In certain parts of the Philippines (Carlattan, San Fernando, La Union), the fry are sorted through wire mesh devices. A wire mesh cylinder, with a bottom but without a top, and whose mesh size is sufficient to permit the milkfish fry to pass through, is placed in the fry sorting basin with some clear water (Figs. 34 and 35). The assorted fry are then transferred into this cylinder. The milkfish fry swim out through the wire mesh into the sorting vessel. The fry of the other species cannot do so, owing to their shapes or sizes, and can be discarded.

Fig. 28. The fine-meshed, gutter-shaped net at the junction of a V-shaped device shown in Fig. 27. It is suspended from two parallel and horizontal bamboos.

Fig. 29. A man setting out for milkfish fry collection in Indonesia. The gear consists of a fine-meshed net fixed to a triangular frame, the fry pot, a shell (resting on the pot), a bamboo stake, and a palm leaf rope with a short bamboo stake at one end.

Fig. 30. The straight rope method of using the palm leaf rope in Indonesia

Fig. 31. The looping rope method of using the palm leaf rope in Indonesia. One end is staked to the ground near the shore line and the free end taken out in a wide circle and crossed over near the fixed end.

Fig. 32. Another stage of the looping rope method using the palm leaf rope in Indonesia. After crossing the free end over the fixed end the former is drawn in short lengths over the latter to decrease the area within the circle. The fry thus concentrated are collected with the fine-meshed net.

Fig. 33. Sorting of milkfish fry in Bonuan, Pangasinan, Luzon, Philippines. The assorted fry are placed in a basin and sorted with a white shell or cup. The sorted milkfish are introduced into the bucket.

Fig. 34. Sorting of fry at Carlattan, San Fernando, Luzon, Philippines. The assorted fry are introduced into a wire mesh cylinder of mesh size just sufficient to let milkfish fry pass through.

Although, at present, all species of fry other than milkfish fry are discarded, shrimp fry of the species Penaeus monodon Fabricius and certain fishes of the Family Siganidae (esp. Siganus vermiculatus Cuvier et Valenciennes) are also used in the Philippines for culture. If these are present in small numbers they are mixed together with the milkfish fry in the fry containers. If they are present in large numbers they are sorted out separately.

1.7.5. Fry counting. The fry are generally counted accurately in the process of sorting. Pebbles or certain seeds are used to represent every hundred or certain convenient fractions of a hundred counted and so aid in the counting. Usually 1000 or 2000 fry are introduced per pot in the Philippines. An extra 50 to 100 fry are added to make allowances for mortalities.

Fry buyers in the Philippines estimate the number of fry within a container fairly accurately by passing a strip of white palm leaf across the bottom of the container. From their experience they can estimate the number by the intensity of the fry appearing against the white background of the palm leaf as it is moved within the container.

1.7.6. Fry containers. Milkfish containers are always circular because all fry in any vessel swim continuously and all swim in the same direction. A circular vessel permits continuous swimming; a vessel with corners does not. The corners interrupt swimming and may cause fry discomfort as they bunch together at the corners.

Generally, both in the Philippines and Indonesia, earthernware pots are used as fry containers (Fig. 36). The evaporation of small amounts of water through the porous material of the pot helps keep contents cool. Hence they are generally preferred to metal or wooden containers, especially when long distances are involved in the transportation of fry.

In Indonesia, wide-mouthed, cane baskets lined with waterproof material are used in addition to earthenware vessels. Each has a flat bottom (Fig. 37) and a lid (Fig. 38), so several such vessels can be stacked for transport. The large width and low height of these vessels permit a good surface/volume ratio for the contents and, consequently, efficient aeration of the water.

1.7.7. Salinity of the water in fry containers. In the Philippines, the fry are transported in marine or brackish water collected from the site of capture. Hence, acclimatization to the salinities of normal brackishwater milkfish ponds is not a problem. The more important factor, under the circumstances, is temperature. Fry mortality during or shortly after stocking is nil or negligible.

In Indonesia, however, the fry are transferred to fresh water after gradual acclimatization during a period of about 5 minutes or more. For transportation they are then transferred into the containers with fresh water into which a handful of salt is added.

1.7.8. Quantity of water in fry containers. The quantity of water in the fry containers is such that as large a surface area as possible is available with a depth of four to six inches of water. This is to ensure good aeration of the water by surface exchange of gases. This exchange of gases becomes more efficient during transport, as the water gets shaken up.

1.7.9. Number of fry per container. Approximately 500 fry are introduced per liter of water in a vessel which permits a water surface of one square cm for every five cubic cm of water. The number is varied according to the time and distance involved before being stocked in the nurseries.

Fig. 35. A close-up of the wire mesh cylinder shown in Fig. 34. The milkfish fry pass out into the basin, while the others remain within the wire cylinder and can be discarded.

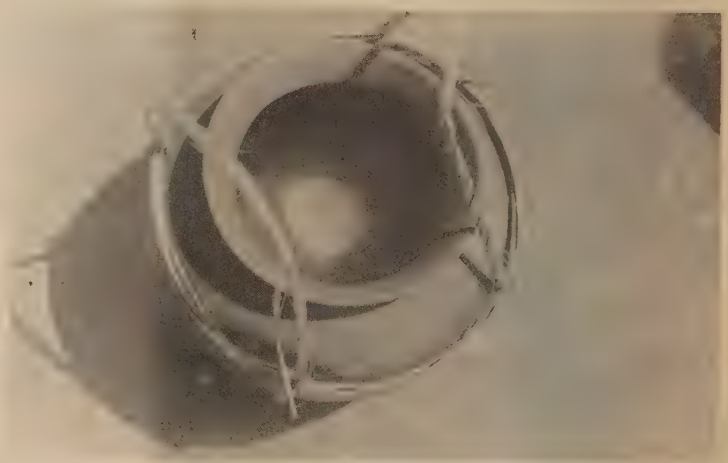

Fig. 36. An earthenware fry container used in the Philippines.

Fig. 37. Fry containers used in Indonesia. In the center is a wide-mouthed cane basket lined with waterproof material with the lid open. In the foreground are some earthenware fry containers.

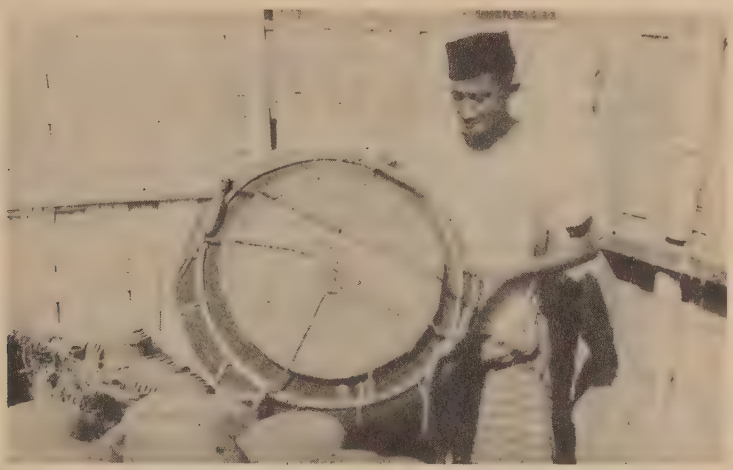

Fig. 38. The cane fry container shown in Fig. 37 with the lid closed.

Fig. 39. Green filamentous algae gathered for planting in fish ponds in the Philippines.

Fig. 40. Small handfuls of green algæ being staked into the mud in a fish pond in Panabo, Davao, Mindanao.

1.7.10. Care of fry during transportation. The contents of the fry containers will have to be kept cool and well aerated during transportation. When halting for any purpose, the vehicle should be parked under some shade. If the water shows signs of being heated, water should be sprinkled onto the outside of the container, either directly or onto some cloth placed on its sides. The evaporation of this water produces a cooling effect. If more than a day is involved in the transport of the fry, sufficient water should be carried in a few spare containers. If the water in a container turns foul, due to fry mortality or other causes, it has to be changed to save the surviving fry.

1.7.11. Feeding fry in containers. If more than two or three days are involved, either in transport or temporary storage before stocking in the nurseries, it is necessary to feed the fry. Very finely ground rice, corn, meat or fish flour or boiled and finely mashed egg yolk are used as fry food. Care has to be taken to use very small quantities of food as excess food may lead to water fouling.

1.7.12. Indications of healthy and weak fry. Healthy milkfish fry keep swimming around continuously in the containers, all in the same direction. This uniform swimming is briefly interrupted on tapping the sides of the container, on the introduction of something into the container or on suddenly moving an object over the mouth of the open container, and is resumed shortly afterwards.

Weak fry, on the other hand, do not exhibit this uniform swimming in one direction. They often swim erratically at the surface of the water and are generally insensitive to any tapping on the container. If there are both healthy and weak fry in a container, the latter can be sorted out and discarded or allowed to recover in separate containers with clean water.

Fry buyers study fry behavior to ascertain their condition of health before purchasing them.

1.7.13. Causes of weakening or mortality of fry in containers. The weakening or mortality of fry in containers can be due to any one or many of the following adverse conditions: a) improper handling during and after capture, b) too sudden changes into water of widely separated extremes of salinity, c) use of water that has turned foul or poisonous by the stagnation of sewage wastes or the discharge of chemical wastes, c) the introduction of too many fry per pot, d) unfavorable water temperatures in the containers, e) keeping the fry in containers for too many days without feeding, f) lack of aeration of the water in the containers, g) fouling of the water due to fry mortality, h) fouling of the water due to the use of excessive amounts of fry food.

1.8. Algae - the natural food of milkfish under cultivation.

Either blue-green algae or green algae are grown in ponds to serve as food for milkfish.

1.8.1. Blue-green algae.

1.8.1.1. Composition. Although the bottom blue-green algal mat has a predominance of blue-green algal components, it is indeed a bio-complex with other plant components and microscopic fauna. From the plant world there are several blue-green algae such as Lyngbya, Oscillatoria, Anabaena and Chroococcus; several species of diatoms such as Pleurosigma, Pinnularia, Nitzschia and Campylodiscus; and a few green algae such as species of Cladophora, Enteromorpha and Chaetomorpha. From the animal world there are several species of flagellates and infusorians and higher forms such as flatworms, roundworms, rotifers, molluscs, bristleworms, crustaceans and insects. With the living components there are also the decomposed or partially decomposed remains of dead plant and animal components of the bio-complex.

Thus milkfish grown on blue-green algae have not only the blue-green algae but also the other components of the bio-complex at their disposal, as food.

1.8.1.2. Method of growing blue-green algae in fish ponds. The pond is first drained, levelled and dried till the bottom cracks. This process takes from one to three weeks. Next, water is let in, with the necessary screening, just sufficient to cover the bottom of the pond. If fertilizers are used they are now applied and the water level maintained for a few days. Soon blue-green algae grow in the pond, rising to the surface of the water towards mid-day and sinking to the bottom towards evening, especially on hot sunny days. Although blue-green algae establish themselves on their own under these conditions, their growth can be accelerated by sowing some lumps collected from elsewhere. Water is let in at high tide daily to make up for losses by evaporation and seepage and, if fertilizers are not applied, the pond is completely drained and the water is renewed every few days in order to replenish the nutrients for the growing algae. As the blue-green algal mat grows thicker and covers the pond bottom, the water level is raised by two to four cm every few days until maximum algal growth is obtained. A water depth of 10 to 15 cm is conducive to good algal growth. When maximum algal growth has been obtained, the pond is stocked with fish and the water level gradually raised to 20 to 40 cm. Beyond this depth the replenishment of algae by growth, while being consumed by the fish, is very slow and there is a danger of the algal stocks of the pond being depleted too soon.

The following care has to be taken during the growth of blue-green algae; 1) the water has to be maintained at an optimum level, 2) if fertilizers are not used, the water has to be freshened every few days during the early stages of algal growth, before stocking the pond with fish, 3) after algal growth has commenced, the bottom should not be disturbed. Turbid water should not be let into the pond. 4) In order to maintain the continuous growth of algae, even after stocking with fish, the water should be maintained at an optimum level and the pond should not be overstocked.

1.8.2. Green algae.

1.8.2.1. Composition. The green algal masses of brackishwater ponds in the Philippines consist predominantly of the genera Enteromorpha, Cladophora and Chaetomorpha. Chaetomorpha linum is generally the most important. Its thalli are multicellular, filamentous and unbranched. Cladophora is branched. Two species of the genus Enteromorpha are common in fish ponds, namely, E. intestinalis and E. tubulosa, but they are not so important as the other two genera.

Like the blue-green algal bio-complex, the green algae of fish ponds also constitute a major portion of a bio-complex, the remaining components being blue-green algae, diatoms and microscopic and macroscopic aquatic animals similar to those associated with blue-green algae.

1.8.2.2. Method of growing green algae in fish ponds. The pond is first drained and the bottom is raked, levelled and dried till it cracks and becomes hard. The drying process takes from one to three weeks. Next, water is let in, with the necessary screening, to a level of about six to ten cm. If fertilizers are used they are applied at this time and the water is not changed subsequently, but any drop in the level caused by seepage or evaporation is replaced by letting in water to the required level. If no fertilizer is applied, the water in the pond is drained at low tide every few days and a fresh supply of water let in during the following high tide to replenish the nutrients for the growing algae. As the green algae grow more and more dense and cover the pond bottom, the water level is raised gradually to a height conducive to good algal growth, i.e., 30 to 60 cm. Over a meter depth of water is generally not conducive to good algal growth.

Given optimum conditions, green algae grow naturally in ponds, but their growth can be hastened by planting them. For this purpose, algae are collected from some of the ponds in which they survive, from other fish farmers or from special green-algal nurseries. Owing to the importance of green algae as milkfish food, some Philippine fish farmers have special nurseries for them. They are transported in boats or carts in a moist state, after allowing the water to drain off (Fig. 39), and are distributed over the pond bottom by one of the following methods.

In one method, small handfuls of algae are dropped on the pond bottom, one for every square meter or so, and partially buried in the mud by applying pressure with a stake (Fig. 40).

In the second method, algae are sown in small handfuls from the dykes, and in the third they are sown uniformly over the pond bottom. Some Philippine fish farmers cut up the algae into small fragments, a few centimeters long, before sowing.

After maximum algal growth has been obtained (Fig. 41), the pond is stocked with fish. To maintain the continuous growth of algae, even after stocking, the water is maintained at an optimum level and the pond is not overstocked.

1.8.3. The effect of soil pH on algal production. It has been confirmed, by researches at the Government milkfish farm at Iloilo, Philippines, that soil pH has a marked effect on the growth of green and blue-green algae. Soft muddy bottoms with a pH of 6.8 to 7.5 favor rapid algal growth. Those with pH less than 6.5 are unfavorable for algal growth and have to be improved. The greater the acidity of the soil the more unfavorable it is for algal growth. The pH is especially low in newly-constructed ponds where certain species of tannic plants such as Rhizophora compose the chief vegetation.

Soils with low pH are improved by the addition of suitable quantities of agricultural lime or quicklime. Agricultural lime can be applied at the rate of 4,000 to 6,000 kilos per hectare for soils with a pH of 4.0, 2,000 kilos for soils with a pH of 5.0 and 1,000 kilos for soils with a pH of 6.0. The lime is evenly strewn over the pond bottom, before growing algae. Raking or ploughing it into the soil makes it more thoroughly effective.

1.8.4. The use of fertilizers in increasing algal production. Fertilization of fish ponds with organic and inorganic fertilizers has proved to be very effective in increasing algal production.

1.8.4.1. Organic fertilizers. The organic fertilizers commonly used in the Philippines and Indonesia are the dung of chickens, ducks, pigs, horses, cattle and human beings. In the utilization of human manure, both in the Philippines and Indonesia, several toilets are constructed over the fish ponds by the owner and the people of the surrounding areas invited to use them, so as to be of mutual benefit for the users as well as the owner. The dung of the various animals serves partly as food for the fish and partly as fertilizers for the algae. Care is taken to avoid overfertilization by this method as this may lead to fouling of the water and cause fish mortality.

Certain other organic fertilizers such as tobacco dust, imported tea-seed cake, rice-bran, soya bean flour and the leaves of certain leguminous plants are also used as fertilizers in the Philippines. Tobacco dust, bought under special licence from cigarette factories, is used as a fertilizer in several commercial nurseries at Dampalit, Malabon (Luzon). It serves the double purpose of killing unwanted fish that may have entered the pond in their egg or larval stages or by burying themselves in the mud at the time of draining the pond. After draining and thoroughly drying the pond, water is let in through a fine-meshed cloth to a level just

Fig. 41. A pond showing a good growth of green algae in the Philippines.

Fig. 42. The use of rice straw as fertilizer in a milkfish pond in East Java.

sufficient to cover the pond bottom. The tobacco dust is next spread or sown evenly over the pond bottom to a thickness of a few millimeters. Blue-green algae are generally grown in these ponds. The water level is maintained accordingly at an optimum level. After about two to three weeks the tobacco dust is no longer harmful to fish and hence the pond can be stocked with fry There is, of course, no further addition of tobacco dust after the pond is stocked with fish. The tobacco dust is used either pure or mixed in certain proportions with rice-bran or soya-bean flour. The unwanted fishes that are destroyed during the application of tobacco dust are allowed to remain in the pond and serve as fertilizer.

Imported tea-seed cake, which is the residue left after commercial extraction of oils from tea-seed, is used as fertilizer in certain parts of Luzon, such as Bataan. Tea-seed also serves the double purpose of killing unwanted fish and subsequently acting as fertilizer. It is used in the same way, either pure or mixed with various proportions of rice-bran or soya-bean flour. The tea-seed cake also loses its poisonous effects on fish after two to three weeks.

Rice-bran is used as fertilizer for blue-green algae in several parts of southern Luzon. The leaves of certain leguminous plants are strewn on the pond bottom to serve as fertilizer during the early stages of algal growth, in some of the Visayan Islands.

In Indonesia (east Java and Madura) the leaves of the mangrove plant Avicinnia and rice straw are used as fertilizers in fish ponds. Avicinnia is planted along the dykes to serve the triple purpose of shade-plants, wind-breaks and fertilizer. During the early stages of algal growth the leaves are gathered from the trees and strewn on the pond bottom. In the use of rice straw as fertilizer (Fig. 42) the straw is distributed evenly over the drained pond bottom and lumps of mud placed over it to prevent it from floating when water is let into the pond. After water is let in, the straw gradually disintegrates and serves as fertilizer.

1.8.4.2. Chemical fertilizers. The use of chemical fertilizers to increase algal production (and consequently fish production) is fast becoming a standard feature of brackishwater fish farming in the Philippines.

The chemical fertilizers generally in use are the Nitrogen-Phosphorus (N-P) and Nitrogen-Phosphorus-Potassium (N-P-K) fertilizers. They are available as various commercial preparations with various proportions of Nitrogen, Phosphorus and Potassium. Some of the proportions commonly in use are N:P:K::16:20:0, N:P:K::12:12:12, and N:P:K::12:24:12.

Algae are generally planted when chemical fertilizers are used. The fertilizer is applied about three days after planting the algae at the rate of about 20 grams per cubic meter of pond water. The application is done from a boat or other floating device that is towed. The application of fertilizer is repeated every fortnight or so, at the same rate, until maximum algal growth is obtained. The pond water should not be changed after the application of fertilizer to avoid wastage of fertilizer except under serious circumstances such as fouling of the water. However, the required water level is maintained by letting in water at high tide.

1.8.5. Wind-breaks for algae. Wind action, especially in large ponds, can cause the algae to be drifted towards and concentrated at one end of the pond. To prevent this, and to ensure as uniform a distribution of the algae as possible, wind-breaks are used. The planting of mangrove plants, such as Rhizophora and Avicinnia, along the outside of the ponds is often sufficient for small ponds of one to three hectares. This is practiced by several Philippine fish farmers and most Indonesian fish farmers. For larger ponds most Philippine fish farmers plant certain profusely-branching twigs on the pond bottom in rows at right angles to the direction of the wind. The length of the twigs depends on the depth of the water and a good portion of them project above the surface of the water. They are planted close together leaving small gaps here

and there for the passage for fish. The distance between the rows of twigs varies from 10 to 25 meters or more, depending on the size of the pond and the strength of the wind in the area. In addition to the rows at right angles to the direction of the wind there are often other rows, separated by similar distances at right angles to these.

Certain fish farmers in Mindanao (Panabo, Davao) turn the soil in large lumps with spades before planting algae. These lumps are allowed to remain during the early stages of algal growth when only a few inches of water is maintained in the pond. These lumps of earth serve the double purpose of being wind-breaks and of bringing certain soil nutrients to the surface of the pond bottom.

1.9. Brackishwater fish pond predators, pests and diseases.

1.9.1. Predators. Certain species of carnivorous fishes, aquatic snakes, birds and frogs prey on the fish in ponds and consequently reduce fish production.

Among the fish are Tilapia, species of Elops, Megalops, Therapon, Lates, Epinephalus, carangids, eels, catfishes, gobies and certain freshwater forms such as Anabas testudineus and Ophiocephalus striatus. They enter the fish ponds either with improperly sorted fish fry or with improperly screened water. The two freshwater species mentioned sometimes bury themselves in the mud at the time of draining and come to the surface when a fresh supply of water is let in. To eradicate such predators, either poisons are used or the pond is drained and dried. The further entry of these fish can be prevented by suitable screening of the water. If, however, some predatory fish have managed to enter the pond, they can be captured with the use of suitable nets, especially when they gather near the sluice gates while letting in a fresh supply of water.

The snakes, lizards, frogs and birds which prey on pond fish are killed or driven off by various methods. The birds, notably storks and kingfishers, are sometimes shot. Scarecrows are often used. In the commercial nurseries of Dampalit (Malabon, Luzon, Philippines), scare-lines are used to scare away birds. These scare-lines consist of bamboo stakes planted in rows and galvanized iron wire lines tied to them at a height of about five to six feet and certain palm leaves and empty metal cans strung on these lines. The noise made by these rustling leaves is generally sufficient to scare away the birds. However, a master line connecting all these lines to the caretaker's hut, when given a few tugs, sets the cans rattling to scare away the somewhat bolder birds.

1.9.2. Pests. The chief pests in brackishwater fish ponds are Tilapia, certain species of snails, bristleworms (Polychaetes), fouling organisms, wood-boring organisms and bund-burrowing crustaceans.

1.9.2.1. Tilapia. In the Philippines, tilapia is rated as one of the worst pests in milkfish ponds. It is a prolific breeder and competes with milkfish for algal food. It also disturbs the pond bottom (and consequently algal growth) during the breeding process, when the males dig depressions of 6 to 12 inches or more in diameter on the pond bottom and invite the females to mate with them.

At the milkfish demonstration farm of the Bureau of Fisheries in Molo (Iloilo, Philippines) the entry of tilapia fry and fingerlings into the fish ponds is prevented by the following method. The main water supply to the pond system is obtained from the bottom of the tidal river through a culvert type of sluice gate which runs across the bottom of the main dyke separating the pond system from the tidal river. Tilapia fry and fingerlings have a tendency to remain at or near the surface of the water and hence do not enter the sluice mechanism.

A screen placed before the entrance to the sluice gate prevents the entry of adult tilapia. This method of preventing the entry of tilapia fry and fingerlings from entering the ponds is effective in places having a high range of tidal movement. Where there is a low range of tidal movement, the prevention of entry of tilapia will have to be with the use of fine-meshed screens.

The owner of a 45 hectare pond system in Mindanao (Panabo, Davao) obtains water for these ponds by pumping it from the sea, instead of using channels from the sea and, in this way, prevents the entry of tilapia into his ponds. He believes the tilapia fry, if any, are killed during their passage through the pump. The cost of operating the pump is negligible compared to the profits from these ponds.

1.9.2.2. Snails. Certain species of snails, especially those belonging to the genus Cerithidea, enter the ponds in their larval stages, grow and multiply rapidly and compete with the milkfish for algal food. When ponds are heavily infested with snails the growth of algae is slow. The tracks left by their movements disturb the growth of blue-green algae.

Snails are destroyed by thoroughly drying the pond before growing algae. Subsequent infestations can be dealt with by the following methods. As the water level drops during low tide, the snails have a tendency to recede with the water line into the pond. The snails that thus concentrate along the water line can be collected either manually or with the use of rakes and destroyed by throwing them onto dry land or by burying them. If it becomes necessary to drain a pond and grow algae almost immediately, the water is drained very slowly and the snails are gathered as they concentrate along the receding water line or from the puddles of water in which they collect.

1.9.2.3. Polychaete worms. The large, balloon-like, mucilagenous egg-masses of the polychaete worm, Marphysa gravelyi Southern, (Family Eunicidae) cause the destruction of appreciable numbers of milkfish fry and fingerlings in the nurseries. Owing to their transparent nature the fish swim into them accidently and, being unable to swim out of them, are killed. The egg masses are collected once a day and thrown on the dykes to dry. The worms responsible for these egg-masses are themselves harmless to fish but if the pond is heavily infested with them the numerous openings of their burrows in the bottom of the pond can retard the growth of blue-green algae. The worms can be destroyed before growing algae in the ponds by sufficiently drying the pond bottom or by the use of suitable poisons.

1.9.2.4. Organisms fouling the sluice gates and bamboo screens. Among the fouling organisms that grow on the sluice gates and bamboo screens and hinder their efficient operation are acorn barnacles, oysters and the serpulid polychaete worm of the genus Neopomatus. The bamboo screens must be regularly dried or inverted to kill them. The organisms that grow on the sluice gates are regularly levered or scraped out with a suitable tool.

1.9.2.5. Wood boring organisms. Wooden sluice mechanisms and the wooden parts of concrete sluice mechanisms are often attacked by wood-boring molluscs (Teredo spp.) and crustaceans (Limnoria spp.). To prevent this, either a suitable wood which is resistant to wood-borers and decay in water is chosen or the wood is treated with anti-wood-borer chemicals. The regular drying of the removable parts of the sluices also helps prevent their being attacked by wood-borers.

1.9.2.6. Burrowing crystaceans causing dyke leaks. Certain species of burrowing crabs and the large, burrowing, scorpion-like crustacean, Thalassina scorpionoides Latreille make their burrows in the dykes and cause leaks. These leaks often worsen and lead to breaching of the dykes. The crabs are caught either manually or with the use of certain nets and their burrows filled up.

An interesting device is used for the capture of Thalassina in certain parts of Luzon (Bonuan, Dagupan City, Philippines). It consists of a short bamboo tube fitted with a bow-and-arrow type of trapping mechanism (Fig. 43). The diameter of the bamboo tube is just sufficient to permit the entry of Thalassina. One end is closed, by cutting the tube to include a node, and the other end is open. The bow, also of bamboo, is fixed near the open end of the tube by means of a slit in the tube. The arrow, which is fixed to the middle of the bow-string by means of a loop in the string, has a flattened blade-like arrow-head which can be passed through a slit near the open end of the tube. The opposite end of the arrow is fixed by means of a string to a short bamboo rod which can be passed through a hole near the closed end of the tube and hooked onto a baiting device within the tube. The arrow-head, when within the tube, prevents the escape of Thalassina if trapped in the tube. The bait generally used consists of fish, shrimp or offal. In loading the device, the bait is first fixed, the arrow drawn backwards and the bamboo rod hooked onto the baiting device. The loaded trap is plugged into the mouth of the burrow of Thalassina with its open end within the burrow (Fig. 44). Attracted by the bait the crustacean enters the tube. While tampering with the bait the hooked bamboo rod is released, the tension between the bow and the string forces the arrow-head into the tube and the animal is trapped. Often burrowing crabs are also trapped in these devices.

1.9.3. General methods of eradicating fish pond pests and predators.

1.9.3.1. Draining and drying of the ponds. Draining and thorough drying of the ponds prior to growing algae in them generally eradicates all fish pond pests and predatory fishes. The drying generally takes from one to three weeks. After thoroughly drying the pond bottom, water is let in, allowed to remain in the pond for a few days, and then drained. This induces certain species of fishes such as Ophiocephalus striatus and Anabas testudineus which bury themselves in the mud to come out and die when the pond is drained. Their subsequent entry into the ponds is prevented by suitably screening the water that is let into the ponds.

1.9.3.2. The use of poisons. Although milkfish ponds are generally drained and dried before growing algae it often happens that there may be insufficient time to dry the ponds thoroughly. This is especially so when the days are very cloudy. Poisons are then used to eradicate pests and fish predators. Certain Philippine fish farmers, who use chemical fertilizers to increase algal production, always use poisons to eradicate pests and fish predators. The fish pests and predators that are killed by the poisons are allowed to decompose in the ponds and serve as fertilizer. The advantage in this method lies in the fact that algal growth can be begun a few days after the application of poisons. By the time the ponds are ready for stocking, after maximum algal growth has been obtained, the poison is no longer harmful to fish. However, the ponds are repeatedly washed to remove the toxic effects.

1.9.3.2.1. Derris root powder. Derris root powder is used in suitable quantities to eradicate pests and fish predators. Most of the pond water is drained before its application to make it more effective and to use it economically. The poison kills the fish pests and predators within one-half to three hours. The pond is next drained and dried for a few days before commencing algal growth. The poisonous effects are lost after a few days and the pond is safe for stocking after maximum algal growth has been obtained.

1.9.3.2.2. The use of insecticides and Shell Endrin. Endrin, a product of the Shell Oil Company, is often used to eradicate fish pests and predators in the Philippines. It is applied at the rate of one-tenth cc or more of original Endrin per cubic meter of pond water after most of the water has been drained out during the hottest part of the day. The process may have to be repeated once or twice more if the first application is not successful in eradicating all the unwanted animals in the pond. The dead fish may be allowed to remain in the pond to decompose and serve as fertilizer. The chemical is harmless to algal growth and algal growth can be

Fig. 43. The device used for the capture of Thalassina scorpionoides, a bund burrowing crustacean, in the vicinity of Dagupan City, Luzon, Philippines.

Fig. 44. The loaded traps for the capture of Thalassina placed in the openings of the burrows.

commenced soon afterwards. Some fish farmers wash the pond a few times by letting in water at high tide and draining it at low tide and dry it for a few days before commencing algal growth. By the time the pond is ready for stocking, after maximum algal growth has been obtained, the chemical is no longer harmful to fish.

D.D.T. and other insecticides are also used for eradicating fish pests and predators in the Philippines. About eight to ten cc of five percent solution of D.D.T. in kerosene oil per cubic meter of pond water is lethal to fish.

1.9.3.2.3. Phenol. Phenol is used in suitable quantities to eradicate unwanted fish and burrowing polychaete worms. Most of the water in the pond is drained before its application to make it more effective and to avoid wasting it. It is applied during the hottest part of the day. Algal growth can be commenced immediately, preferably after one or two washings of the pond. As in the case of Endrin the pond is safe for stocking after maximum algal growth has been obtained. The use of phenol is prevalent in the vicinity of Dagupan City in Luzon.

1.9.3.3. The use of poisons which subsequently act as fertilizers. Tobacco dust and tea-seed cake are used in certain parts of Luzon for eradicating fish pests and predators. These serve as poisons which subsequently act as fertilizers. They are used either pure or mixed in various proportions with rice bran or soya-bean flour. Tobacco dust is used in several of the commercial nurseries of Dampalit (Malabon) and tea-seed cake is used by certain fish farmers in Bataan (see 1.8.4.1.).

1.9.3.4. An important precaution to be taken in the use of poisons. An important precaution to be taken when it is intended to use poisons for fish pests and predators is to inform other fish farmers in the vicinity beforehand. This will enable them to take the necessary precautions for preventing the entry of the poisonous water that is drained from ponds in which poisons are used. This will also enable them to retain sufficient quantities of water in their ponds until such time as the water in the common channels is safe for use again.

1.10. Nursery ponds.

1.10.1. Preparation of nursery ponds prior to stocking. Approximately one and a half to two months of preparation is necessary before the nursery ponds are ready for stocking with fry. After the old stock of fish is removed, each nursery pond is drained and the bottom is stirred with rakes and dried for one to two weeks. The eradication of undesirable species is thus achieved. However, certain fishes that may bury themselves in the mud such as Ophiocephalus spp., Anabas testudineus and species of eels, can be stimulated to come out by letting water into the pond again. They can be subsequently destroyed by repeating the draining and drying process (see 1.9.3.1.).

After thoroughly drying the pond bottom till it hardens and cracks, water is let in through a fine-meshed screen or cloth (see section 1.6. and Fig. 18) which can prevent the entry of the eggs and larvae of undesirable species of fishes and crustaceans. The level of the water should be just sufficient to cover the pond bottom. This is the best condition for the growth of blue-green algae and the associated bio-complex which serves as the best natural food for milkfish fry. If fertilizers are used for the promotion of algal growth, suitable quantities are applied now. As the algal mat grows the water level is raised gradually to a few inches. If fertilizers are used the water is not changed except under serious circumstances such as fouling of the water. Only the necessary water level is maintained by letting in the required amount of water. If no fertilizers are used the pond water is totally changed about once in five to seven days in order to replenish the supply of nutrients for the growing algae.

1.10.2. Stocking of nursery ponds.

1.10.2.1. When to stock the nursery ponds. The nurseries are ready for stocking with fry when maximum algal growth has been obtained in them. Great care is taken to ensure that the fry of undesirable species of fishes are sorted out before stocking the milkfish fry.

1.10.2.2. Acclimatization of the fry to nursery pond water. The fry have to be acclimatized to the temperature and salinity of the nursery pond water when stocking. Stocking is done at a time when the pond water is cool, preferably during the early morning hours. The fry containers are first allowed to remain partially immersed in the pond to roughly equalize the temperature of the water in the container with that of the pond water. Next, small quantities of pond water are introduced into the container either manually or with a small cup and allowed to mix with the water in the container. When the container is full some of the water is removed and pond water again introduced in the same manner. It may be necessary to repeat this process until, after five or ten minutes, (depending on the differences in salinities between the water in the container and that of the pond) the salinities are equalized approximately. The container is then tilted to let the fry escape into the pond. From their experience, fish farmers generally use their sense of taste for approximately determining the salt content of water.

1.10.2.3. Stocking rate in nursery ponds. The stocking rate in nursery ponds is from 25 to 50 fry per square meter of pond surface, depending on the amount of algal growth in the ponds. The nursery ponds can be overstocked to keep the fish stunted and these fish resume normal growth rate when given more space and food.

1.10.3. Management of nursery ponds. The water in the nursery ponds will have to be maintained at an optimum level for algal growth. It should be freshened frequently by letting out some of the water during low tide and letting in the required amount of water during the following high tide. Water should be available in a nearby storage pond to attend to any urgent situation, even during low tide. Special care has to be taken to ensure that the ponds do not dry up due to evaporation or seepage of water or due to leaks in the dykes. This can cause some or all of the fry stocks to die. The water level should be raised during heavy rains to avoid too sudden changes in salinity. The water should be allowed into the ponds only through fine-meshed screens. A look-out should be constantly maintained for all types of fish predators. Artificial food such as rice bran should be kept in readiness for use when natural food stocks are depleted. Artificial feeding is at the rate of about five to ten kg per day per hectare for ponds with about 25 to 50 fish per square meter of pond area. Feeding is usually twice daily, once in the morning and once in the afternoon.

1.10.4. Rearing period in nursery ponds. After about one to two months in the nursery ponds the fry are two to four inches long and are ready for transfer to the intermediate (or transition) ponds. If the fish stocks of the nurseries are just sufficient for the pond system for one harvest they are all transferred to the intermediate ponds. Otherwise only the required number are transferred to the intermediate ponds while the others are allowed to remain in the nurseries. The fingerlings can be kept stunted in the nurseries for a period of a year and a half or more and resume normal growth rate when given more space and food.

1.10.5. Commercial nurseries and their management. Some parts of the Philippines (Dampalit, Malabon) own large-scale nurseries or commercial nurseries (Fig. 45) in which milkfish fry are grown to the fingerling stage and sold to other fish farmers. Unlike in the nurseries which form part of the normal pond systems, the stocking rate is higher in the commercial nurseries being from 250,000 to 500,000 per hectare. The general principles employed in their management are the same as those for the normal nurseries, except for the fact that greater care and vigilance is exercised owing to the larger numbers involved. As the algal food stocks are exhausted, artificial feeding is commenced using rice bran.

1.10.6. The capture of fingerlings from the nurseries and their transfer to intermediate ponds. The best method of capturing the fingerlings makes use of the tendency of milkfish to swim towards and into a fresh supply of water (Fig. 46). During low tide a part of the water from the nursery pond is let out and the fingerlings allowed to suffer the discomforts of the hot sun during the day. In the meantime, a small area of the common pond (catching pond) opposite the nursery pond is enclosed by bamboo screens. Bamboo screens are next fixed to form a V-shaped one-way device (Figs. 19 and 20) in such a way that the fingerlings can leave the nursery but cannot come back. During the next high tide the slabs at the sluice gate are removed and a fresh supply of water is allowed to enter the pond. The fish swim into this fresh supply, pass through the opening at the junction of the wings of the V and collect in the confined area.

This method can be used for capturing part or all of the fingerlings. Some fish farmers use fine-meshed drag nets to drive the fingerlings towards the confined area while letting in a fresh supply of water. This is done especially when there is insufficient tidal movement at the time of capture.

The fingerlings that have been confined in the catching pond are collected in half-submerged fine-meshed nets which are generally rectangular. They are then removed from this net in buckets and quickly transferred to the intermediate pond or the counting net. Care is taken to ensure that there is a fresh supply of water passing the confining net or the counting net.

As a rule, in the Philippines, the number of fingerlings is estimated before their introduction into the intermediate ponds. In many fish ponds in Indonesia the fry are reared for a few weeks in the nursery ponds and released directly into the final pond without letting them grow first in an intermediate pond. The nursery ponds in such cases are small, slightly elevated ponds within the final ponds and the fingerlings are released into the latter by breaking a part of the dyke of the nursery ponds.

1.10.7. Counting of fingerlings. An interesting method is used in the Philippines, especially in the Malabon Region, for counting large numbers of fingerlings fairly accurately. This method is also employed in the commercial nurseries. From the catching pond the fingerlings are introduced by means of buckets to a rectangular counting net (Fig. 47). This net is tethered to four stakes at the four corners such that the four sides are above the surface of the water. The net is situated close to the catching pond in clear water, preferably in a stream of fresh tidal water.

By means of a bamboo that is rolled underneath the net at right angles to the longer side of the net (Fig. 47) the fingerlings are concentrated together at one end of the net. By means of another bamboo of smaller diameter which is placed underneath the net at right angles to the first (Fig. 48) the fingerlings are divided into two equal portions. If the fingerlings are for sale, as is usually the case in the commercial nurseries, this and subsequent divisions are by agreement between the seller and the buyer. One portion is released into the remaining larger part of the net by manipulations of the net and the large bamboo, while the other portion is retained within the area enclosed by the two bamboos and the two sides of the corner of the net. The latter portion is similarly sub-divided thrice so that the final portion left is 1/16th of the total number. This is the portion that is counted accurately. Although the various divisions are by agreement between the seller and the buyer both make use of their experience to outwit each other. The seller ensures that the portion that is retained for further sub-division, and finally for counting, contains a larger number than the one discarded into the rest of the net so that in the final calculation the total number is higher. The buyer does the opposite.

Fig. 45. A commercial milkfish nursery farm in Dampalit, Malabon, Luzon. The water supply channel to the pond system is on the extreme left. The fry are initially stocked in the fry pond (in the center). After they grow to about 1½ inches they are transferred to bigger ponds (on the right and in background). The bamboo stakes seen are meant for scare lines to scare away predatory birds.

Fig. 46. Milkfish fingerlings milling towards a fresh supply of water.

Fig. 47. A fingerling counting net being operated in Dampalit, Malabon, Luzon. By rolling the bamboo underneath the net the fingerlings have been confined within a small part of the net (on the left).

Fig. 48. A subsequent stage in the counting operation shown in Fig. 47. By means of another bamboo of smaller diameter the confined fingerlings are divided into two equal portions. One portion is released into the larger portion of the net and the other is retained for further subdivision. The final portion, which is 1/8th, 1/16th or 1/32 of the whole is counted accurately.

The final portion is then counted as follows: A small bowlful of fingerlings (Fig. 49) is counted accurately. Another bowlful or two may be counted to determine the average number of fingerlings per bowl more satisfactorily. The number of bowlfuls of fingerlings in the final portion to be counted is then determined each bowlful, as it is counted, being discarded into part of the net containing the discarded fingerlings. The final bowl, if not full, is counted accurately. The total number of fingerlings in the counting net is equal to the number of fingerlings per bowl x the number of bowlfuls + the number in the last incomplete bowl x 16. Other fractions of the total such as 1/8th or 1/32th may be decided upon for the final counting by agreement between the buyer and the seller.

In this way up to 300,000 or more fingerlings can be counted within the very short time of 15 to 30 minutes with minimum handling of the fish.

If the intermediate pond that is to be stocked is within a minute's running distance or so, the fingerlings are quickly transferred into it by means of buckets (Fig. 50). Since up to 1,000 to 2,000 fingerlings can be transferred at a time per bucket it is dangerous to keep such large numbers for longer than a minute or so in them. If the distance is a bit longer the fish are transferred in the counting net itself by carefully dragging it along the water supply channels. The net can be manipulated into the intermediate pond itself through its sluice gate. If the buyers' ponds are far away and if they are accessible by the tidal rivers and the water supply channels, the fingerlings are transferred by means of special fingerling boats.

1.10.8. Special boats for transportation of fingerlings. The commercial nursery pond owners of Dampalit and Malabon in the Philippines employ special boats for the transportation and delivery of large numbers of fingerlings to buyers. These boats (Fig. 51) are capable of transporting from 25,000 to 100,000 or more fingerlings at a time. Often a mechanized boat, which is itself capable of transporting fingerlings, is used to tow one or other similarly sized but unmechanized boats with fingerlings.

The boats are large flat-bottomed and provided with water circulation mechanisms. At one end of the bottom of the boat is fitted a short bamboo tube with a wire screen at one end. The screened end of the bamboo tube lies within the boat and the other end projects outside and under the boat. This tube could be tilted forwards or backwards or maintained vertically downwards in order to regulate the rate of flow of water through it into the boat. Near the opposite end of the boat there is a pump for pumping water out of the boat. The intake pipe of this pump is surrounded by a wire screen to protect the fingerlings. The inflow and outflow of water can be adjusted to be equal or may be varied according to the needs. Should there be a failure in the pumping mechanism there are special buckets or baskets with which the water from the boat can be baled out manually while a fresh supply of water keeps entering through the bamboo tube. This was the method that was originally used to transport commercial quantities of fingerlings. A few such boats are still in operation.

This method of transporting fingerlings is done at high tide, during the cooler parts of the day. Times of rough weather or fouling of the water along the route to be taken by the boat are avoided. Care is taken to avoid very shallow areas in order to prevent the inlet tube from letting in mud or getting clogged and to prevent the boat itself from being grounded.

The circulation mechanism of the boat enables the gradual acclimatization of the fingerlings to the water found along the route taken by the boat. By the time the boat arrives at its destination the fingerlings are acclimatized to the water in the tidal river that supplies the ponds of the buyer and hence can be stocked immediately. Milkfish fingerlings can be transferred in this manner from brackishwater ponds to freshwater bodies for stocking purposes. Laguna de Bay, a freshwater lake near Manila in Luzon, has been stocked with milkfish fingerlings by

Fig. 49. The counting of the final portion in the fingerling counting operation shown in Figs. 47 and 48. A small bowl or cup is used for counting the number of cupfuls. The number of fingerlings in a cup is counted accurately. The total number of fingerlings is equal to n x the number of fingerlings per cup x the number of cupfuls. (1/n represents the final fraction counted).

Fig. 50. The transfer of fingerlings from the counting net shown in Figs. 47-49 to a nearby pond.

Fig. 51. Special boats for transporting very large numbers of milkfish fingerlings in Dampalit, Malabon, Luzon. The bamboo water inlet tube is shown in the central foreground. The water exit pump, with its tube surrounded by a wire screen, is in the center.

Fig. 52. Total draining method of harvesting milkfish from a fish pond in East Java. Most of the milkfish have been harvested and the people are busy gathering shrimps, gobies and other miscellaneous species.

the Philippine Bureau of Fisheries by this method along a river leading to it. Since this river is brackish along its lower reaches and fresh along its upper reaches, the fingerlings are acclimatized to fresh water by the time they arrive in the lake and can be stocked immediately.

1.11. Intermediate (or transition) ponds.

1.11.1. Preparation and stocking. By the time fingerlings in the nurseries are ready for stocking in the intermediate ponds, the latter should be ready with maximum algal growth. The preparation of the intermediate ponds is similar to that of the nursery ponds. Either blue-green algae or green filamentous algae can be grown as food for the fish. The stocking rate is about 5 to 20 fingerlings per square meter of pond surface depending on the amount of algal food available.

1.11.2. Management of intermediate ponds. The management of intermediate ponds is similar to that of nursery ponds. The management of the water level depends on the type of food grown.

1.11.3. Rearing period in intermediate ponds. The fingerlings are reared in the intermediate ponds until they are three to six inches long. This takes from one to two months. Some fish farmers maintain fingerling stocks which are just sufficient for one harvest from their final ponds. Others maintain sufficient fingerlings for more than one harvest.

1.12. Final ponds or harvesting ponds.

1.12.1. Preparation and stocking. By the time the fish in the intermediate ponds are ready for stocking in the final or harvesting ponds the latter should be ready with maximum algal growth. Either blue-green algae or green filamentous algae can be grown as food.

1.12.1.1. Transfer of fish from the intermediate ponds to the final ponds. The transfer of fish from the intermediate ponds to the final ponds is effected by one of the following methods:

Where the various ponds are constructed around a common water supply and catching channel the water level in the final pond to be stocked is first raised. During the low tide that follows, the water level of the intermediate pond concerned is lowered and the fish subjected to the discomforts of the hot sun during the day. In the meantime a bamboo screen, V-shaped, one-way device (Figs. 19 and 20) is fixed at the outlet of the intermediate pond into the common or catching pond. A similar one-way inlet device is fixed at the sluice gate leading from the common pond to the final pond concerned. At the beginning of the high tide that follows the water is let in through the common pond into the intermediate pond keeping the intermediate pond sluice gate open. Suitable fixed bamboo screens confine the fish within that part of the common pond that lies between the intermediate pond and the final pond concerned. When all, or a sufficient number of, fish have entered the confined area of the common pond by swimming against the inflow of a fresh supply of water, the supply of fresh tidal water is stopped and the sluice gate of the final pond is opened. As the water previously stored in the final pond flows into the common pond the fish now swim against this flow of water and enter the final pond through the one-way device at the sluice gate. This process may have to be repeated during the subsequent tides if the transfer of fish to the final ponds is incomplete; if the fish from more than one intermediate pond are to be transferred to one final pond; or if the fish from one intermediate pond are to be transferred into more than one final pond.

In a second method, which is a slight modification of the first, the fish from the intermediate pond are allowed to swim against a fresh supply of water into a confined area and from there are transferred in a rectangular, fine-meshed net into the final pond. This rectangular net is similar to the fingerling counting net described in section 1.10.7. It is gently

introduced into the confined area containing the fish and as many fish as possible taken into it. It is then gently towed along in the water with suitable manipulations at constricted channels and sluice gates into the final pond and the fish are released after closing the sluice gate.

1.12.1.2. Stocking rates in final ponds. The following stocking rates have been tried out successfully at the Iloilo Demonstration Fish Farm (Philippines) after using Nitrogen-Phosphorus-Potassium fertilizers to produce an algal growth of about 2.14 kg (damp weight) or green filamentous algae per square meter of pond surface:

Average length of fish	Stocking rate per hectare	Rearing period
5-6 inches	1,500 fish	3 months
4-5 inches	1,800-2,500 fish	3 months
3-4 inches	2,200-2,500 fish	3 months

If algal production is less the stocking rate is correspondingly lower.

1.12.2. Rearing period in the final ponds. If the fingerlings pass through intermediate ponds before being stocked in the final ponds the rearing period in the latter is approximately three months. If the fingerlings are transferred from the nurseries directly into the final ponds the rearing period in the latter is from four to seven months, depending on the type and quantity of food grown and the stocking rate.

In some of the ponds around Dagupan City (Luzon, Philippines) the rearing period in the final ponds is only from six to eight weeks. Here the fish are fed with blue-green algae and they are reared in intermediate ponds before being stocked in the final ponds.

1.13. Harvesting of milkfish.

1.13.1. Factors considered when deciding on a harvest. Several factors are taken into consideration when deciding on a harvest. The fish should have attained a marketable size of two to three fish per kilogram. If after the fish have reached a marketable size there is a danger of their losing weight due to depletion of algal food stocks, the fish are harvested. The last but not least important factor is economic. Periods of milkfish glut in the market are avoided and times when the fish would fetch the highest price are chosen for harvesting milkfish.

1.13.2. Methods of harvesting milkfish. Harvesting of a pond can be either total or partial.

1.13.2.1. Draining method. Total harvesting of a pond can be achieved by draining the pond water through suitable bamboo screens placed at the sluice gate and collecting the fish that concentrate near the sluice gate with suitable nets. The miscellaneous fishes and prawns that have grown in the pond are also collected by similar methods or manually (Fig. 52).

1.13.2.2. Method using the common pond. Where the ponds are around a common water supply channel and catching pond, both total and partial harvesting can be achieved in the following manner: The water in the pond to be harvested is first lowered until the fish suffer the discomforts of the hot sun during the day. A V-shaped bamboo screen, one-way outlet device is placed in such a way that the fish that leave the pond cannot return to it (Fig. 53). If the common pond is too long, another bamboo screen is fixed across it at a suitable place to reduce the area in which the fish are to be confined prior to capture (Fig. 54). During the next high tide water is let in through the common pond and the sluice gate of the final pond is kept open. The fish swim into the fresh supply of water, pass through the one-way bamboo screen device and collect in the confined area of the catching pond (common pond). After all, or the

Fig. 53. The arrangement of bamboo screens in the common pond for harvesting milkfish at the Government Demonstration Fish Farm, Iloilo, Philippines. The pond on the right foreground has been partially lowered for harvesting. The sluice gate in the foreground is closed. When a fresh supply of water is let into the pond concerned the fish swim out through its open sluice into the common pond (center). They then pass into a confined area of the common pond through the one-way bamboo screen arrangement shown in the center.

Fig. 54. Another view of the common pond shown in Fig. 53 with the harvesting operation in progress. The common pond passes under the caretaker's hut (also shown in Fig. 53), but the catching area is decreased by placing a bamboo screen across it in front of the hut. A long drag net is being used for capturing the fish.

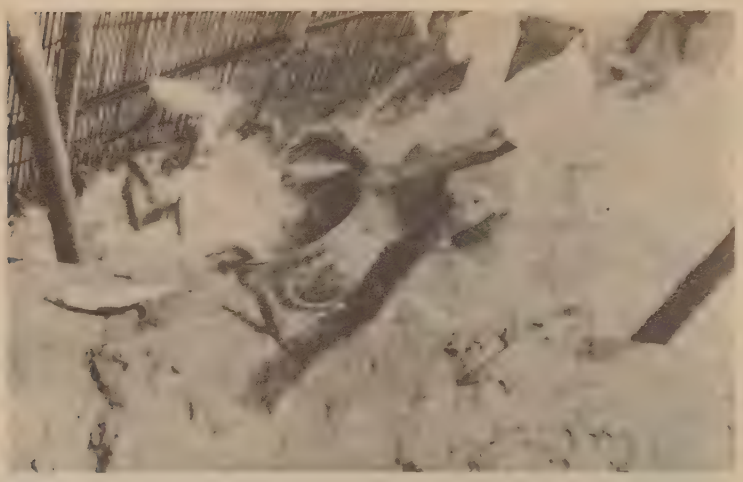

Fig. 55. A basket being used to capture the fish during the harvesting operations shown in Figs. 53 and 54.

Fig. 56. A scoop net with a circular frame used for harvesting operations in Iloilo, Philippines.

Fig. 57. Wooden boxes, with a capacity of about 800 kilos, used for shipping milkfish from Iloilo to Manila.

required number of, fish have entered the common pond they are caught with long drag nets (Fig. 55), baskets (Fig. 56) or scoop nets with a circular frame (Fig. 57). As the large numbers of fish that are caught with the drag net struggle violently and are difficult to handle, they are concentrated within a part of the net and held under water for some time till they are exhausted and then transferred to the fish baskets.

1.13.2.3. The bamboo screen method. In the vicinity of Dagupan City (Luzon, Philippines) long bamboo screens, composed of smaller sections joined together, are used for harvesting milkfish. Several people take part in this operation. The bamboo screen is spread out at right angles to the length of the pond from one dyke to the other and held vertically. An inch or two of the bottom of the screen is pressed into the mud along its whole length to prevent the escape of fish under the screen. Beginning from the end away from the sluice the screen is gradually moved towards the sluice. The top of the screen is held by the hands and the bottom is pushed forwards with the feet, care being taken to ensure that the screen is pressed a few inches into the mud along its whole length. When the fish have been concentrated within a small area near the sluice gate they are gathered with suitable nets and introduced into the fish baskets.

1.13.2.4. Castnet method. In several parts of Indonesia and the Philippines partial harvesting of milkfish is achieved by the use of castnets, a few or several people taking part in the operation.

1.14. Packing and transportation of milkfish.

If only a short time is involved in the transportation and sale of milkfish, they are transported in cane or palm leaf baskets without any special precautions. If more than 12 to 15 hours are involved the fish are packed in layers between layers of crushed ice in baskets lined with banana leaves. This method is adopted in several parts of Indonesia and the Philippines.

In some parts of the Philippines milkfish are packed for transport by steamer in the following manner: Large wooden boxes, capable of holding about 800 kilos (Fig. 57) are used. Each box is first lined with banana leaves and a four-inch layer of flaked ice is spread uniformly on the bottom. A layer of fish is then arranged over it with their bellies against the ice and another layer is arranged above the first with their bellies upwards. Another four-inch layer of ice is placed over this and the fish arranged in a double layer as before. This alternate arrangement of ice and fish is repeated until the box is full. Then a final layer of ice is placed on top (Fig. 58), hammered down with a wooden mallet, and the lid is nailed to the box. In this manner the more easily decomposable parts of the fish, their bellies, are kept against the ice and preservation is more efficient. Fish are shipped in this manner from Iloilo to Manila and are well preserved up to about three days.

1.15. Criteria used by consumers in purchasing milkfish.

In addition to the criteria generally employed to determine the freshness of fish, certain others are used by Philippine milkfish consumers to satisfy their taste preferences. Fish with a large amount of fat lining the internal abdominal walls are preferred to those with little or no fat. The retailer often displays a fish with its belly slit lengthwise for the customer to ascertain this. However, this can be ascertained even without examining the abdominal cavity by examining their dorsal and ventral body contours. The more convex the dorsal and ventral body outlines are the greater is the fat content.

Fish farmers of two regions in the Philippines, Dagupan and Malabon, each claim to produce the fattiest and tastiest milkfish in the Philippines. A generally accepted fat, from the consumer's point of view, is that fish grown on blue-green algae are fatter and tastier than

Fig. 58. Packing milkfish for transport by steamer from Iloilo to Manila. The banana leaves lining the box and the final layer of crushed ice are shown.

Fig. 59. Shrimp traps used in fish ponds of East Java. The trap on the extreme left shows the opening for entry of shrimps. The trap on the extreme right shows the opening at the top for getting the shrimps out. A lamp can be introduced through this opening and hooked inside the trap to attract the shrimps.

those grown on green algae. From these standards most Dagupan fish farmers and several Malabon fish farmers produce equally good fish. However, although milkfish from several parts of the Philippines come to the Dagupan and Manila markets, the consumers who purchase their fish from these markets have a method of identifying good Dagupan fish which they generally prefer. The lower ramus of the caudal fin is shorter than the dorsal ramus. This is due to "wastage" by friction against the bottom of the very shallow Dagupan fish ponds in which blue-green algae are grown as fish food.

1.16. Processing of milkfish.

1.16.1. Smoked milkfish. Smoked milkfish, a Philippine delicacy, is readily available in the Philippine markets and it is prepared as a home or cottage product by simple and inexpensive methods.

The smoking apparatus is simply an empty 100 to 200 gallon oil drum with the top and bottom removed, the inside thoroughly cleaned, and an opening of about six inches diameter cut on its side near one end. The smoking trays are made of woven cane or bamboo and are just large enough to be slipped through the end of the drum and rested on one of the circular strengthening grooves within the drum. The lower grooves can be reached by suitably bending the trays. Rice husk or saw-dust from selected timbers is used as the smoke producing material. It is introduced through the hole near the bottom of the drum.

The fish are first salted in concentrated brine. In the absence of any scientifically accurate instruments, the fact that a raw guava fruit (Psidium sp.) floats in saturated brine and sinks in unsaturated brine is used to determine the saturation point of brine. The salted fish are arranged on the trays and smoked. A lid placed over the drum can be adjusted to regulate the escape of smoke. Further addition of smoking material is done through the hole near the bottom of the drum. The beautiful golden brown color of smoked fish is often enhanced by painting the fish with a brush soaked in a suitable golden-yellow dye during the smoking process.

1.16.2. Home canning. Milkfish is being canned in some of the homes of certain parts of the Philippines (Pangasinan) employing the general principles of canning, pressure cookers and portable canning machines.

1.17. Milkfish farming in solar salt fields.

Some of the solar salt fields in Luzon (Philippines) and the Government solar fields at Kalianget (Madura, Indonesia) are used for milkfish farming during the rainy months. Thus good use is made of the salt fields which would otherwise be idle during this period.

1.18. Milkfish farming in fresh water.

Since milkfish can be easily acclimatized to fresh water it is suitable fish for farming in freshwater ponds and for stocking natural freshwater bodies in order to increase their productivity. In several parts of the Philippines, especially in Pangasinan, milkfish is grown in freshwater ponds either alone or in combination with other freshwater fish such as gourami and common carp. In Indonesia (especially Java) milkfish is farmed in some freshwater ponds and is also often used for stocking rice fields in the farming of rice with fish.

2. SHRIMP FARMING

2.1. Species of shrimps farmed.

In Indonesia and the Philippines several species of commercially important species of shrimps enter milkfish ponds with the water supply during their larval and post-larval stages and are harvested with the milkfish, but Penaeus monodon Fabricius is collected in the larval stage and farmed in the Philippines. This shrimp, which is called the tiger shrimp or jumbo shrimp, is generally farmed with milkfish. Since these shrimps feed on living or dead plant and animal matter there is no problem about their food in milkfish ponds.

2.2. Tiger shrimp larvae and methods of their capture.

2.2.1. Tiger shrimp larvae. Tiger shrimp can be easily and unmistakably identified by the characteristic light brown to dark brown of the body and their similarities to bits of twigs in the water. When they are about one and one-half inches long they are more translucent and are bluish-green.

2.2.2. Methods of tiger shrimp larvae capture.

2.2.2.1. Capture with milkfish fry. Tiger shrimp larvae are often captured with milkfish fry in the various devices meant for collecting milkfish. Their method of handling is similar to that of milkfish fry. If they are present in small numbers they are mixed with the milkfish fry in the containers. If they are present in large numbers they are sorted into separate containers.

2.2.2.2. Grass line method. A special method is employed for the capture of tiger shrimp larvae in the Dagat-Dagatan and Malabon Regions of the Philippines. Loose bundles of half to one kilogram of a certain species of grass are tied to a string at intervals of one to five meters and this line is laid out in tidal rivers and estuaries where the larvae are likely to occur. Periodically the larvae that gather on these bundles for shelter are collected with a fine-meshed scoop net. The net is smoothly introduced under each bundle and the bundle shaken to drive the larvae into the net. The larvae are then handled in the same way as milkfish fry.

2.3. General principles employed in shrimp farming.

The general principles employed in shrimp farming, either pure or mixed with milkfish, are the same as those for milkfish farming. The layout of the ponds is similar and the food should preferably be blue-green algae and the associated bio-complex.

2.4. Stocking rates.

The rates of stocking tiger shrimp in the various ponds depend on the sizes of the ponds, the type and amount of food grown in them and on whether they are to be farmed pure or mixed with milkfish. In pure shrimp farming the stocking rates in the nurseries and final ponds are 200,000 to 300,000 fry and 20,000 to 50,000 fingerlings per hectare. When shrimps are farmed with milkfish, as is usually the case, suitable adjustments are made between their numbers in order to grow them both to marketable size with sufficient food in the ponds.

2.5. Transfer to final ponds.

Given optimum conditions, the tiger shrimp larvae can be transferred from the nurseries to the final ponds within two to three months. An appreciable number of the shrimps that survive in the ponds cannot be gathered because they tend to bury themselves in the soft mud.

To minimize such losses, intermediate ponds are generally avoided and the shrimp are transferred from the nurseries directly into the final ponds. However, if shrimp are found in the intermediate ponds meant for milkfish, they are also captured and transferred to the final ponds meant for the shrimps either pure or mixed with milkfish.

The capture of the shrimps in the nurseries for transfer to the final ponds is effected either by trapping them or by draining the pond.

2.5.1. Trapping methods. Various devices are used for trapping shrimps. Generally bamboo traps with one-way bamboo screen barrier-guides leading to their openings are used (Fig. 59). Shrimps are nocturnal so these traps are operated at night with a lamp inside. It is generally believed that the shrimps are attracted by the light. As the shrimps gather in the traps they are periodically collected with scoop nets and transferred to the final ponds. This method does not enable all the shrimps to be captured at once. Several days are involved, the shrimps caught each day being transferred to the final ponds.

2.5.2. Draining method. In the draining method the water is drained very slowly to let the shrimps that have buried themselves in the mud sense the danger of their environment being dried up, which makes them move with the receding water line. As they gather near the sluice gate they are gathered with scoop nets and transferred to the final ponds.

2.6. Rearing period in the final ponds.

The shrimps are ready for harvesting after four to six months in the final ponds when they will weigh 10 to 20 per kilogram.

2.7. Harvesting.

The methods of harvesting shrimps are the same as those for transferring them to final ponds. If they are farmed with milkfish both species are ready for harvesting after four to seven months in the rearing ponds. The harvesting of the shrimps may be commenced about a month before the harvesting of the milkfish, in which case traps are used. The shrimps that are captured every night in these traps are sold or consumed; They are allowed to remain alive in the traps till such time as they are required. Those shrimps that have escaped being trapped are captured during the harvesting of the milkfish. In this case one must resort to the draining method.

For the draining method to be most effective for the harvesting of shrimps the draining is done very slowly. This will give enough time for the shrimps that have buried themselves to sense the danger of their being stranded in the mud without water and hence move with the receding water. The shrimps are gathered with scoop nets as they collect near the sluice gate. However, some of those that may have buried themselves are gathered manually by feeling in the mud.

2.8. The manufacture of prawn (shrimp) crackers.

The tastiest prawn crackers in the East are believed to be produced in Surabaja (East Java, Indonesia). The ingredients used are Cassava (Tapioca) yam flour, prawns, eggs, salt and sugar. The tapioca flour for this purpose is obtained by finely scraping the yams with a toothed scraping blade, allowing the scrapings to settle in water, decanting the water and drying the residue in trays in the sun. In the preparation of a high quality product of prawn crackers in Siddoadjo (East Java), peeled prawn tails and tapioca flour are used in equal ratios by weight. For every two pounds of tapioca flour, two pounds of prawns, two whole eggs, one ounce salt

and two ounces sugar are used. They are pounded together, using enough water to produce a homogeneous dough-like mass. This mass is then divided and shaped as required with the use of suitable moulds, removed from the moulds, placed on cane or bamboo steaming trays and steamed for about two hours.

In the steaming process, a shelf-like arrangement containing the steaming trays is placed over a cast-iron pan heated with water. It is covered with a cylindrical metal cover which is provided with a handle and a few small vents for the excess to escape. The steamed product is allowed to cool and harden somewhat for a period of about 24 hours and sliced to a thickness of about two to three mm with a device similar to a bacon or ham slicer. The slices are then sun-dried till they are hard and brittle and packed for sale.

When the dried product is fried in oil or cooking fat it swells out into delicious and crisp crackers. Best results are obtained when the crackers are well dried before being fried.

3. SIGANID FISH FARMING

3.1. General.

Certain species of fishes of the Family Siganidae (esp. Siganus vermiculatus Cuv. and Val.) are farmed either pure or, as is generally the case, with milkfish in the Philippines. These fishes are algal feeders and hence there is no problem with regard to their food in milkfish ponds. However, these fishes cannot tolerate low salinities and high temperatures. Consequently, their culture is possible where the salinity of the water is constantly nearer that of sea water and where the water does not get heated too much during the day. If siganids are farmed pure, the water level in the ponds is maintained over 50 to 75 cm or, if they are farmed with milkfish, the ponds are deepened in certain parts so that the siganids can retreat into these parts during the hotter parts of the day.

3.2. Principles employed in siganid fish farming.

The general principles employed in siganid fish farming are similar to those used in milkfish farming. The layout of the ponds, type of food grown, stocking rates and rearing periods in the various ponds are similar.

3.3. Capture of siganid fry.

Siganid fry are often captured in the various devices used to collect milkfish fry in the Philippines. However, two special methods are used in the Pangasinan Region (Luzon).

3.3.1. Method using green filamentous algae as lures. Bundles of green filamentous algae are suspended in the water from stakes in tidal rivers and estuaries where the fry are likely to occur. The fry that are lured by this food are periodically collected with a scoop net which is taken gently under the bundles of algae.

3.3.2. Method using a scare line and a fine meshed net. A scare line with several strips of white palm leaves strung on it is dragged along stretches of water likely to contain siganid fry, driving the latter into a large fine-meshed net. A fine-meshed scoop net is used for collecting the fry from it.

3.4. Care in the handling of siganid fry.

As siganid fry are very sensitive they are not taken out of the water. Their transfer from the capturing device to the fry container and from one container to another is always effected with some water, as in the case of milkfish fry.

3.5. Transport of siganid fry.

If the transport of siganid fry is merely from the site of capture to a pond in the vicinity, they are placed in fine-meshed bamboo or cane baskets suspended in water and gently towed along the tidal river or water supply channel leading to the ponds. A small bundle of green filamentous algae is suspended in the water within the basket to serve as food and to keep the fry interested in it while they are being towed along. The passage of water through the meshwork of the basket helps to keep the fry supplied with well aerated water. There is also gradual acclimatization of the fry to the pond water by the time they arrive in the ponds.

Siganid fry are also transported in the earthenware pots used for transporting milkfish fry. However, only about 150 to 300 fry are generally placed in each pot. A small bundle of

green filamentous algae is suspended in the water within the pot to serve as food. Care is taken to keep the pots containing siganid fry in a cool place.

3.6. Stocking rates.

If siganids are farmed pure, the stocking rates are the same as for milkfish. If, however, as is generally the case, they are farmed with milkfish suitable adjustments are made in the numbers of both species in order to maintain optimum stocking rates for the conditions prevailing in the ponds.

3.7. Harvesting of siganids.

The siganids attain a marketable size within five to seven months. Hence, if they are farmed with milkfish, both can be harvested together by draining the ponds. However, castnets are often used to harvest the siganids separately.

4. OYSTER AND MYTILUS FARMING

4.1. Oyster farming.

4.1.1. General. Oysters are farmed extensively in several parts of the Philippines, especially in Binakayan (Cavite Province) and Binmaley (Pangasinan). The four most commercially important species of oysters in the Philippines are Ostrea iredalei Faustino, O. malabonensis Faustino, O. palmipes Sowerby and O. cucullata Born.

In general oyster culture consists of collecting the young oysters (or spat) on suitable spat collectors (or cultch) and allowing them to grow in a suitable place till they are ready for harvesting. Any clean, rough surface is generally suitable as oyster cultch. No special care has to be taken regarding their food, as oysters are plankton feeders and strain their food from the water.

4.1.2. Conditions necessary for oyster farming. The following conditions are necessary for oyster farming: Suitable culturable species of oysters should be available. The intended location should have a hard bottom and should not be subject to silting, strong currents and flooding by fresh water. The water should be clear and of a suitable salinity (18 to 30 p.p.t.). The degree of success of the venture depends also on the number of spat-falls per year and their regularity.

4.1.3. Methods of oyster culture.

4.1.3.1. Irregularly strewn cultch. Various articles such as oyster shells, small rocks, scrap-iron, etc. are irregularly strewn over the firm muddy bottom of an area in which the oyster spat are likely to settle. The spat that settle on them are allowed to grow in situ until harvest time.

4.1.3.2. Simple planting of cultch. Sticks, bamboos, tree trunks, shells or other material is planted in suitable places and the spat that settle on them allowed to grow in situ until harvest time.

4.1.3.3. Planting of cultch in oyster plots. There are several methods of construction oyster plots in which the oysters are kept above the bottom and thus prevented from being subject to silting.

4.1.3.3.1. Vertically planted bamboo plots. Bamboos are planted vertically in the mud in parallel rows to form plots of various areas leaving sufficient room among the bamboos for the passage and interchange of water. The spat that settle on them are allowed to grow in situ until harvest time.

4.1.3.3.2. Bamboo plots with both vertical and horizontal parts. These are similar to the plots described in the preceding sub-section but have several horizontal bamboo components as well (Fig. 60).

4.1.3.3.3. Bamboo plots with dead oyster shells as cultch.

4.1.3.3.3.1. Tray method. Four bamboo stakes are planted vertically at the corners of a rectangle or square and four horizontal bamboos braced to them below the surface of the water to form the sides of the rectangle or square. Galvanized iron wire mesh is fixed to the horizontal components to form a "tray" on which the oyster shells can be placed to serve as cultch. The spat that settle on them are allowed to grow in situ until harvest time. The plots are of various sizes, and very large ones can be constructed with the use of more vertical components to give added support for the tray-like portion.

4.1.3.3.3.2. Oyster shells strung on wire and fixed horizontally. This method is similar to that described in the previous sub-section, but for the fact that dead oyster shells are strung at intervals of a few inches on galvanized iron wire and fixed horizontally to the horizontal sections of the plot instead of using a galvanized iron-wire tray.

4.1.3.3.3.3. Oyster shells strung on wire and hung vertically. This is the method now adopted by the Government Oyster Farm at Binakayan and by several oyster farmers in the vicinity. The culch used here consists of dead oyster shells strung on galvanized iron wire at intervals of about six inches and hung vertically from the horizontal sections of bamboo plots.

Each such culch string is two to three feet long, the length depending on the depth of the water. In stringing the shells to the wire a hole is made through each shell and the wire passed through it and looped under it to keep it in place on the wire. The top end of the wire is curved into a hook.

The bamboo plots are made as follows: Two parallel rows of bamboos are planted vertically in the mud with a distance of about one meter between the rows. Each row is about 10 meters long and composed of four vertical bamboos equidistantly apart. The members of each row are planted opposite those of the other. These vertical sections are in turn braced by horizontal bamboos (Fig. 61) along each row and short bamboos connect the opposite pairs of vertical bamboos. Long iron nails are used to brace the bamboos. Staples are then driven into the horizontal sections of the plot at intervals of 6 to 12 inches and the culch strings are hung from them. The horizontal sections of the plot are approximately at the mean low tide level. There is generally a gap of two to three meters between plots for the passage of boats (Fig. 62).

4.1.4. Rearing period and harvesting of oysters. Oysters are ready for harvesting when their right valves are 2.5 to 3.5 inches or more long. From the spat stage it takes about 8 to 12 months for them to attain this size. They are best harvested before the spawning season (March to May in the Philippines). Various tools are used to dislodge them from the culch. Only those that have reached a marketable size are removed, while the others are allowed to grow further.

4.1.5. Marketing of oysters. The oysters are sold with or without shells. If with shells, they are thoroughly washed to remove epizoic organisms and are sold by weight or by cans of fixed volume.

Various blade-like tools are used for shucking oysters. The shucked oysters are generally sold by the gallon. Some oyster dealers transfer their shucked oyster flesh into water of lower salinity before sale to make them appear fat. The temporary fattened appearance thus obtained is due merely to the absorption of water by endosmosis. After removal from this medium of lower salinity there is a quick loss of nutritious body fluids. Moreover, spoilage and putrefaction take place more rapidly.

4.1.6. Consumption of oysters. Oysters are generally consumed raw in the Philippines, care being taken to avoid oysters that are not freshly shucked or those from areas subject to sewage and drainage outlets. They are also consumed after cooking in various ways.

4.2. Mytilus culture in the Philippines.

A species of green-lipped Mytilus (M. smaragdinus) is cultured at the Government Oyster Farm at Binakayan and other places. Often culch meant for oysters is found to be overgrown with large clusters of Mytilus.

Fig. 60. A view of the Government Oyster Farm in Manat, Pangasinan, Luzon. Bamboo cultch with vertical and horizontal components is used in the tidal river.

Fig. 61. A view of the Government Oyster Farm in Binakayan, Cavite Province, Luzon. Oyster shells strung on wire are hung from bamboo plots to serve as cultch. Spaces for the passage of boats are left between plots.

Fig. 62. Side view of a bamboo oyster plot under construction at the Government Oyster Farm, Binakayan, Cavite Province, Luzon.

In Mytilus culture the hanging cultch used in the vertical stringing method described in 4.1.3.3.3.3. is examined for Mytilus spat. When Mytilus has grown to about one-half inch or more, they can be easily separated from the oysters by cutting through their byssus with a pair of scissors. The use of force in detaching them results in injury which is often fatal to the animals. The detached Mytilus can be made to re-attach themselves to fresh cultch by placing both the cultch and the Mytilus well covered with sea water in trays. They re-attach themselves by the secretion of new byssus. The cultch with the Mytilus is then hung up in bamboo plots and cultured separately. They may also be hung up in the oyster plots among the cultch which bear the oysters.

The rearing period for Mytilus is the same as for oysters. Unlike oysters, Mytilus are eaten cooked in various ways.

5. GREY MULLET FARMING IN HONG KONG

5.1. General.

Grey mullet (Mugil spp., esp. M. cephalus) is farmed either alone or with Chinese carp in the slightly saline fish ponds of Kowloon, Hong Kong (Fig. 63). At present there are about 300 fish ponds totalling about 600 acres, of which about 90 percent are slightly brackish. The depth of the water in the ponds is generally from three to four feet.

5.2. Capture of Mugil fry and fingerlings.

5.2.1. The use of a net suspended from a pole. A square frame with a diagonal measurement of about six feet is fitted with two diagonally-placed, bow-shaped bamboo strips. Each strip is about three inches wide and the junction of these strips is firmly bound with twine. The square frame and the sides, up to about one foot, are lined with a net of 1/8 inch mesh size. This device is suspended by a string from a bamboo pole and operated from a boat or a pier. The net is held below the surface of the water and lifted as soon as a reasonable number of fry or fingerlings are over it.

Variations of this net, in which the bottom may be bowl-shaped or conical, are also used.

5.2.2. The use of small seine nets. Seine nets about 30 feet in length and of 1/4 to 1/8 inch mesh are used along the shallower parts of bays, especially around sewage and freshwater outlets where mullet fry and fingerlings gather in large numbers.

In both these methods there is a considerable amount of rough handling with the result that there is an appreciable number of mortalities either before or after stocking in the ponds.

5.3. Counting of fingerlings.

The fish pond owner estimates the number of fingerlings brought by the gatherer in the following manner: A wicker basket of known weight is placed in the water, the fingerlings are introduced into it and the basket with the fingerlings is lifted out of the water after hooking it on to a spring balance. The weight recorded on the balance after the water has run out of the basket minus the weight of the basket gives the weight of the fish. The average number of fingerlings of a particular size per pound is known and hence the approximate number of fingerlings in the basket can be estimated.

The weighing has to be done very gently and quickly or there will be losses due to injuries suffered by the fingerlings during this operation.

5.4. Stocking rates.

The usual stocking rate in Kowloon is about 6,000 grey mullet fingerlings with 600 to 1,000 carp fingerlings per acre.

5.5. Feeding.

The food of these fish in ponds consists of the excreta of pigs, ducks and human beings. Pig sties and duck pens are constructed near the ponds by the fish pond owner himself or by others. For the pig sty and duck pen owners this is a means of disposal of the unwanted excreta of the animals. For the fish pond owner it is means of obtaining food for his fish. The surplus

excreta serves as fish pond fertilizer. In the utilization of human manure, toilets are constructed over the fish ponds and the people of the surrounding areas invited to use them. The dung of herbivorous animals such as cattle, horses and goats can also be used as substitutes.

5.6. Harvesting.

Harvesting is usually by means of castnets or seine nets. The general yield from well-maintained ponds is about one ton per acre per annum with a numerical loss of about 50 percent.

6. RICE-CUM-FISH FARMING

6.1. General.

Farming of fish with rice in East Java has yielded such good results that the practice is being adopted very quickly by rice field owners. At present there are about 4,000 hectares of rice fields in which fish are grown simultaneously.

Although most of the rice fields in East Java depend solely on rains for water, several of them can retain this water until the harvest. The period between the sowing and harvesting of rice is also long enough for the stocking and harvesting of fish.

The species of fishes that are farmed together with rice are common carp, Puntius javanicus, Tilapia and milkfish. In freshwater rice fields milkfish have to be acclimatized to freshwater before stocking. In brackishwater rice fields where certain species of brackishwater rice are grown the fishes used are Tilapia, P. javanicus and milkfish. Puntius javanicus, a true freshwater fish, can tolerate only low salinities up to about 15 p.p.t., and hence can be stocked in rice fields of low salinities.

6.2. Modification of normal rice fields for rice-cum fish farming.

The normal rice fields need slight modification for rice-cum-fish farming. Within the field along its periphery there is a shallow ditch (Fig. 64). This ditch is about one to three meters wide and 30 to 50 centimeters deep, depending on the size of the field.

The average annual production of fish from these fields is about 300 kg per acre. The loss of income per hectare due to not planting rice in that area occupied by the ditch is negligible compared to the income from the harvest of fish.

During the rainy season the fish can use the entire rice field area for swimming and feeding. As the water level drops during the months that follow, the fish can retreat into the shallow ditch. The food of the fish consists of the natural growth of algae and the associated bio-complex.

6.3. Stocking rates for Puntius javanicus.

The stocking rate for P. javanicus, which is the chief fish used for rice-cum-fish farming in East Java, is 10,000 to 20,000 fingerlings per hectare.

About 300 kg are harvested per hectare with a numerical loss of about 60 to 70 percent. There is often a considerable loss of fish shortly after stocking in low saline brackish water due to improper acclimatization to the water of the rice field and due to improper handling. The stocking rate is also apparently too high for a fish that grows to an average weight of one-quarter to one-half kg, especially in consideration of the fact that, although the stocking rate is calculated per hectare of rice field, only a small part of this area is available for the fish a few weeks after the rainy season. About one-tenth to one-fifth of the present stocking rate, with proper handling and acclimatization, should yield a similar or larger harvest of bigger fish.

6.4. Advantages in farming fish with rice.

The income from the rice fields is increased by farming fish with rice. The losses from not planting rice in the area occupied by the ditch is negligible compared to the gains from the

Fig. 63. A grey mullet farm in Kowloon, Hong Kong.

Fig. 64. A rice field in East Java where fish is farmed with rice. Along the periphery of the rice field is a ditch into which the fish can retreat during the hotter parts of the day and as the water level drops during the rainless months.

Fig. 65. A view of the Government Fresh Water Fisheries Station in Punten, East Java, for the selective breeding of common carp. The ponds are of the terraced type.

sale of harvested fish. It is generally accepted by such farmers that this practice helps to increase the yield of rice. This is attributed to the extra watchfulness and care shown by the farmers and to the fact that the ditch helps to retain sufficient water in the fields for a longer period after the rains. This also helps certain varieties of rice that branch at the base to produce more branches and hence more ears of rice.

7. FRESHWATER FISH FARMING

7.1. In the Philippines.

Freshwater fish farming practices in the Philippines are being intensified by the breeding of exotic species of fish such as Common carp (Cyprinus carpio Linn.), Giant Gourami (Osphronemus gouramy Lacepede), Snake-skin Gourami (Trichogaster pectoralis Pallas), the Bluegill (Lepomis macrochirus Rafinesque) and Black Bass (Micropterus salmoides (Lacepede). Tilapia mossambica Peters was introduced to the Philippines in May 1950. By human and natural dispersal it has now established itself so successfully that it is regarded as a serious pest by milkfish farmers.

The Bureau of Fisheries of the Philippines has several freshwater hatcheries distributed throughout the country where freshwater fish are bred. The fish are reared to the fingerling stage and supplied to freshwater fish farmers or used for stocking natural bodies of water. Milkfish fingerlings are also stocked in natural bodies of fresh water after being acclimatized to fresh water.

7.1.2. Breeding of Giant Gourami. The Giant Gourami is grown in mud ponds and allowed to breed naturally without any inducement. The breeding fish gather grass and other material and build a nest in which they lay their eggs. The appearance of oil with a characteristic odor on the surface of the water indicates the gourami has spawned. The nests are then removed, the eggs are placed in shallow trays with a few sprigs of Hydrilla or some other water plant and allowed to hatch. The fry are fed with egg yolk or infusorian culture. When the fry have grown to about one-half inch in length they are transferred to aquarium tanks. After they have grown to about an inch long they are transferred to mud ponds. However, they can be grown in mud ponds throughout if care is taken to ensure that predatory fishes do not enter the ponds.

The more advanced method of inducing gourami to breed can also be used. A bamboo stem about one meter long is split into strips leaving an unsplit portion of about 25 cm. The strips are parted and bamboo hoops fitted within the circle of parted strips so as to form a conical frame with a circular opening at the base of about 25 cm in diameter. The hoops are fastened with string to the strips and the tip of the unsplit portion is cut obliquely. The conical part of the frame is partially stuffed with grass, or any type of palm fiber, and fixed to the pond bottom by driving the unsplit portion into the mud of the pond bottom. The frame is fixed horizontally about two feet below the surface of the water. Some grass of fiber is strewn in the pond. On seeing this, the sexually mature gourami are induced to breed. They complete the nest building process using the grass of fiber strewn in the pond and also by gathering grass and other material growing in the pond.

In addition to inducing gourami to breed in ponds this method can also be used to induce gourami to breed in natural bodies of water and thereby increase the productivity of such waters.

7.1.3. A simple form of rice-cum-fish farming. Certain species of indigenous carnivorous fishes, such as Ophiocephalus striatus Bloch, Clarias batrachus Linn. and Anabas testudineus Bloch, are collected from rice fields after harvesting rice. Some rice farmers collect the fry and fingerlings of these fish from irrigation channels and other water bodies and stock them in rice fields. The fish thrive on the aquatic fauna that grow in the rice fields. This is a simple form of rice-cum-fish farming.

7.2. In Indonesia.

7.2.1. General. In Indonesia there is intensive cultivation of freshwater fishes such as Common carp, Puntius javanicus, Giant Gourami and Tilapia. There is a great demand for Tilapia even in very small sizes among the low income groups.

7.2.2. Carp farming.

7.2.2.1. Layout of ponds. Carp ponds are best layed out in one of two ways, depending on the nature and elevation of the land and the source of water supply.

The best ponds are of the terrace type, as found at the Government Fresh Water Station in Punten (East Java) (Figs. 65 and 66). Terraced ponds are possible along the sides of gradually sloping hills where a perennial supply of water could be obtained from a diverted spring or stream. The water supply to the ponds is generally by means of concrete drains (Fig. 66). The mud ponds are laid out on either side of the main drain which has diversions to each pond. Wooden slabs placed at the junctions of these diversions can control the flow of water into the ponds.

The second type of pond system is adopted where the site is more or less uniformly level. The ponds are constructed on either side of a main supply channel which is a diversion from a stream, irrigation channel or river. In dry areas, where there is much loss of water by seepage, the supply channels are out of concrete.

In general the ponds are constructed in such a manner that they can be drained and dried. Various screens (Figs. 67 and 68) are used at the entrances to the ponds to prevent the entry of unwanted species of fishes.

7.2.2.2. Food of carps. Common carp generally feed on the blue-green algae and animals found on the bottom of the pond. However, supplementary food such as rice bran and bread crumbs is also used.

7.2.2.3. Use of fertilizer in carp ponds. The growth of algae in the ponds is enhanced by the use of fertilizers. Generally organic fertilizers such as the dung of cattle, horses and goats are used. In the application of such fertilizers, a small portion of a corner of the pond is enclosed by a partition of woven bamboo strips (Figs. 69) and the fertilizer placed within it. The quantity of fertilizer used is regulated to avoid fouling the water.

7.2.2.4. Breeding of common carp.

7.2.2.4.1. Selection of breeders. The carp are placed in small wicker baskets half-submerged in pond water (Fig. 70) or in small cement ponds (Fig. 71). To determine whether they are ready to breed, the application of a little pressure in front of the vent in an antero-posterior direction causes either the ova or the milt to be extruded if they are ready to breed.

7.2.2.4.2. The ratio of males to females. The breeders are introduced into the breeding ponds in the ratio of two males to one female.

7.2.2.4.3. Breeding methods. Under natural conditions carp lay their eggs on branching, small-leaved water plants or grasses. Their eggs are sticky when freshly laid and adhere to such material as they are laid. However, the fibers of certain palms can be used as substitutes in the breeding ponds.

Fig. 66. Another view of the Government Fresh Water Fisheries Station in Punten, East Java. A mountain stream is diverted along concrete drains to supply the ponds with water. The ponds are constructed on either side of the main concrete drain (seen on the left).

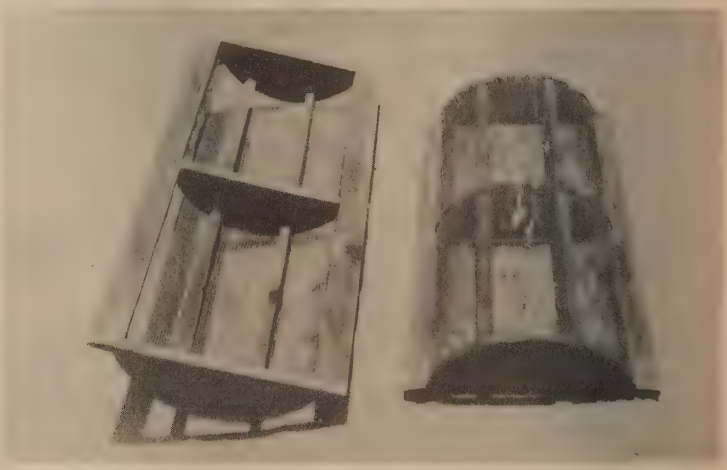

Fig. 67. Wire mesh screens used in certain freshwater fish ponds of East Java.

Fig. 68. The method of using the wire screens shown in Fig. 67 in a culvert type of sluice gate. A fine-meshed cloth is being used to prevent the entry of the eggs and larvae of unwanted species of fishes.

Fig. 69. The corner of a carp pond in East Java showing the enclosure for the application of fertilizer.

Fig. 70. A view of the Government Fresh Water Fisheries Station in Punten, East Java, showing the closely woven cane baskets used for the handling and selection of carp breeders. The carps can be quickly transferred in these baskets from one pond to another before the water leaks out completely.

Fig. 71. An assistant at the Government Fresh Water Fisheries Station in Punten, East Java, demonstrating the correct method of handling carps. The carp shown is a breeder and it is being selected from the small cement ponds (shown). By the insertion of wooden partitions these cement ponds can be subdivided for segregating the breeders by sex.

Fig. 72. The use of the fiber of certain palms as material for the attachment of eggs in breeding carp, in East Java. The fiber is fixed to a bamboo frame and the whole structure is fixed horizontally about six inches below the surface of the water. The breeding pond on the left is being dried in preparation for breeding carp. One of the stakes to which the frame containing the fiber is fixed is shown in the left background.

Three methods are used for breeding carp. In one, grass is allowed to grow in the central part of the breeding pond before letting water into it and stocking with the breeders. The grass serves for the attachment of eggs.

In the second, the Kakaban method, the fiber of certain palms is tied to a bamboo frame (Fig. 72) which is fixed to stakes so the frame is about six inches below the surface of the water. The fiber serves for the attachment of the eggs.

In the third method both the above methods are used in combination, the grass as well as the fiber serving for the attachment of eggs.

The eggs are allowed to hatch out in situ and the fry are allowed to grow in the ponds. During the early stages of fry growth there is sufficient natural food in the breeding ponds. Later, finely-ground rice bran is used as supplementary food.

The breeding ponds are generally rectangular and average 75 to 100 square yards. They are drained and thoroughly dried before commencing breeding operations. The water that is let into the breeding ponds is thoroughly screened to prevent the entry of eggs and larvae of predatory freshwater fishes.

7.2.3. Farming of Puntius javanicus.

7.2.3.1. General. Puntius javanicus, an indigenous freshwater fish from Java, is farmed in freshwater fish ponds. It is, however, farmed extensively with rice in East Java. It is abundantly available in the wild state in the Bangawan Solo River. It breeds in the upper reaches of the river and about 60,000,000 fry are caught annually along about 60 kilometers of its lower reaches.

7.2.3.2. Capture of P. javanicus fry. Fine-meshed nets fitted to rectangular wooden frames (Fig. 73) are used in the capture of P. javanicus fry from the river. A white shell or cup is used to transfer the fry from the net to the containers. The fry containers are generally earthenware pots. Great care is taken to discard carnivorous insect larvae such as dragon-fly larvae and the larvae of predatory freshwater fishes.

It is very difficult to differentiate the fry of P. javanicus from the fry of other species of Puntius that are found in the river. Hence all Puntius fry are collected and reared in nurseries. P. javanicus can be easily identified after they have attained a size of about one inch.

7.2.3.3. Breeding of P. javanicus. There are several Government Fresh Water Stations in East Java where P. javanicus is bred (Fig. 74). Best results are obtained if the breeding ponds cover more than one-third of an acre. The water should be clean. The pond is drained and dried before letting in water for breeding operations. The height of water in the ponds should be about one to two feet. Males and females are introduced into the breeding ponds in approximately equal ratio by weight. The breeding process is accompanied by sounds made by the male while pursuing the female. No special inducements such as egg collectors are necessary. The fry that hatch out are allowed to grow in the breeding pond until they are one to two inches long and either transferred to other ponds or distributed to rice farmers for rice-cum-fish farming.

Fig. 73. The capture of Puntius javanicus fry along the lower reaches of the Bangawan Solo River in East Java. The fry capturing nets and the fry containers are shown.

Fig. 74. The capture of P. javanicus and common carp breeders from a fish pond in East Java. The man on the extreme left demonstrates the correct method of handling P. javanicus while the other two demonstrate the method of handling common carp. The use of a bamboo screen in the capture of fish from the pond is also shown.

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